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DUBOIS & FRANCOIS'S MACHINE FOR COMPRESSING AIR.

THE use of compressed air is now rapidly extending in the larger industries and in mining. A simplification of the mode of compression and a completer study of the subject of applying the apparatus have reduced the item of expense and permitted a host of industries to make use of this agent with success. Every one at present recognizes the advantages to be derived from the use of compressed air engines in mines, and the time is doubtless not far distant when air motors of all kinds will be called upon to perform a great part of our motive equipment, although the work restored, compared with that which has generated it at the surface, is shown by quite a low coefficient of utilization.

But, in industrial economy, the benefit of an installation is always measured by taking the sum of all the relative advantages, and not by considering a single difference to which we might erroneously attribute an absolute value.

Mechanical rock drilling apart, the industrial value of which is no longer to be discussed, it will be understood that the progressive rise in the cost of manual labor is to lead to the adoption in many cases of new applications. The mining of coal, transportation of products (especially in coal mines), aeration of preparatory works, and researches by sounding, all call for the services of compressed air. The use of this agent has extended only since the time it was employed in the piercing of Mont Cenis, and the compressors of the eminent engineer Sommeiller were the first apparatus of their kind. At Mont Cenis the compressors were actuated directly by hydraulic wheels, and it was useless to try to obtain high speeds in the compressing cylinders.

Later on, when, under the impulse given it by the use of the Dubois & Francois rock drills, the application of compressed air became general in mines, it was discovered that, as soon as a velocity of fifteen revolutions per minute was exceeded, the product furnished by the Sommeiller compressor was no longer proportionate to the volume generated by its piston. The establishment of such a result led to the construction of a system of high speed compressing apparatus, which were often defective because little account was taken of the experience acquired by means of the Sommeiller machine. In this latter the velocity was limited, because, on the one hand, the suction valves did not close quickly enough, and, on the other, because the upper part of the compressed liquid finally absorbed a certain quantity of air, which rendered it elastic and formed the beginning of a dead space. In adopting high speed work the inertia of the compressed liquid may also lead to disturbances in the suction when it does not follow the piston perfectly.

In the construction of their compressor Messrs. Dubois & Francois have taken advantage of these observations, and, while preserving the liquid piston, have given it less space to act in. The suction valves are hung so as to move by rolling friction (Fig. 6), and so that the opening of one brings about the closing of the other.

The compression columns, A B, are contracted above so that the upper part of the compressed liquid (that which holds compressed air in solution) is at every pulsation forced into the accumulators in order to give up the absorbed gas therein. This water does not return to the compressors until it has passed through several reservoirs.

As may be seen in Fig. 6, when the piston is at the end of its stroke the level of the water on the side of the sucked-in air descends very low in the pump chamber so as not to diminish the product, although the quantity of water is sufficient to fill the compressing column and penetrate everywhere where a dead space might occur.

The two injection nozzles, P and P, take water under pressure from the accumulators at the upper level. In this way a certain quantity of oil, which is swimming in these reservoirs, is injected with the water and thus serves to lubricate the cylinders of the compressor. The water afterward returns to the accumulators to serve anew when it has reached the upper part.

The height of water in the accumulators is kept constant by a regulating float.

Experiments made with one of the more powerful of these machines have permitted of the following *resume* being drawn up. The compressor was 0·45 m. in diameter and the piston had a stroke of 1·2 m.

Velocity of the piston per second, 1·2 m., 1·6 m., 2 m.; number of revolutions per minute, 30, 40, 50; volume that the compressing cylinders have to generate in order to produce one cubic meter of compressed air at an absolute pressure of five atmospheres, 5·32 cubic meters, 5·43 cubic meters, 5·814 cubic meters. The volume generated by the pistons being unity, the real volume of air sucked in at the pressure of the atmosphere and at the initial temperature is 0·94, 0·92, 0·86.

As regards the mechanical performance of the motor, it will be remarked that there is nothing

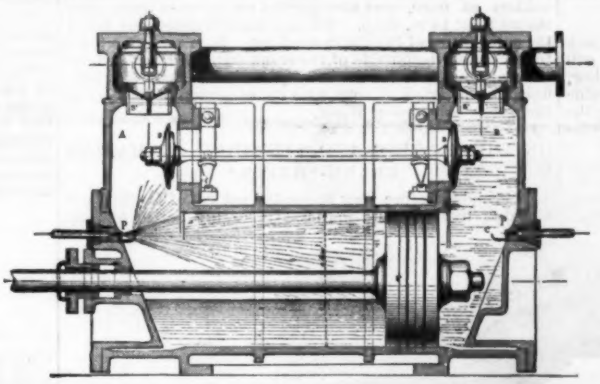


FIG. 6.—LONGITUDINAL SECTION OF THE COMPRESSING CYLINDER. (ONE-TENTH ACTUAL SIZE.)

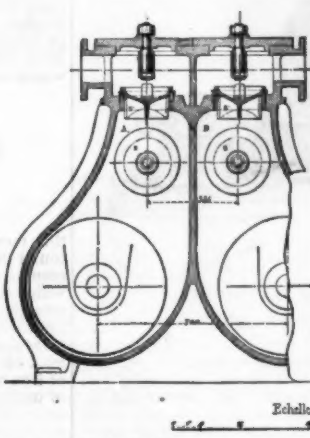


FIG. 7.—TRANSVERSE SECTION THROUGH THE FORCE VALVES.

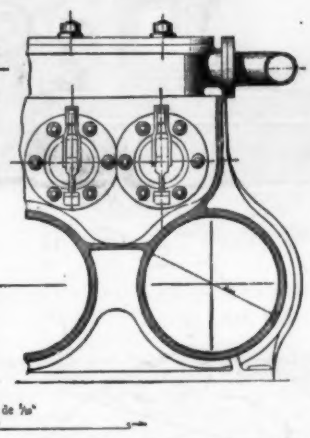


FIG. 8.—TRANSVERSE SECTION THROUGH THE AXIS OF THE CYLINDER.

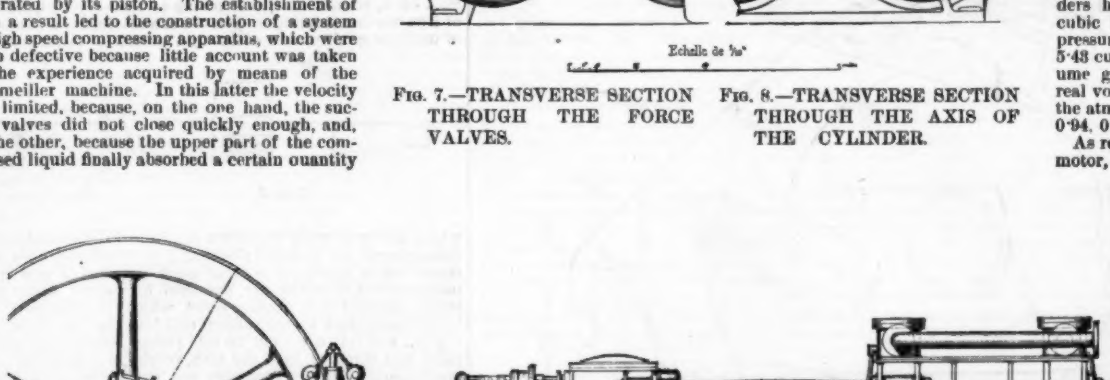


FIG. 1.—ELEVATION.

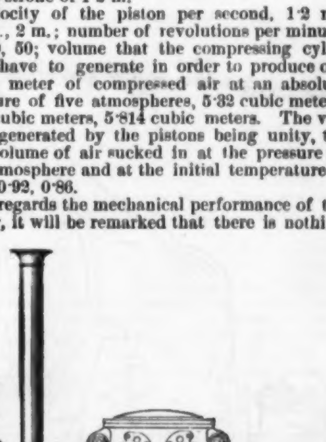


FIG. 2.—PROFILE VIEW OF THE STEAM CYLINDERS.

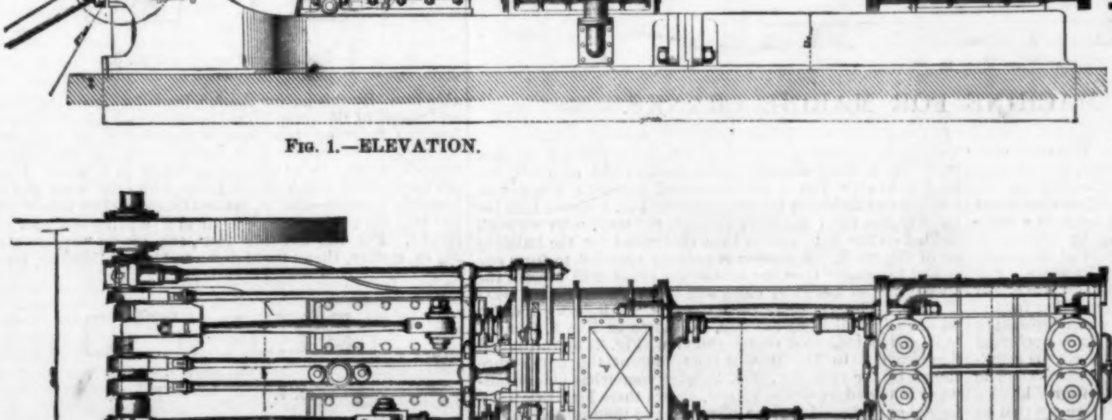


FIG. 3.—PLAN VIEW.

FIG. 4.—PROFILE VIEW OF THE COMPRESSING CYLINDERS.

DUBOIS & FRANCOIS'S AIR COMPRESSOR.

to prevent the latter from being provided with all the modern improvements. It may be easily constructed according to the compound system, with an initial pressure of 6 kilogrammes, and with large expansion and high speed of piston. After this its consumption per horse ought not to exceed 0·85 to 0·90 kilogramme of coal.

Compressed air, employed as a means of transmitting power, cannot, then, taking all things into consideration, be so costly to use as is generally thought.

The majority of direct-acting mine engines work without expansion, and a number of lifting engines operate with notable counter-pressures during the exhaust; and these conditions, so unfavorable to a saving in fuel, are nevertheless accepted as entirely natural because they are inherent to the system of apparatus employed.

We may conclude that, although we have not yet succeeded in utilizing the expansion of compressed air, we may expect from its work a more economical performance than that of the majority of steam motors installed in coal or other mines.—*Annales Industrielles.*

IMPROVED CRANK PIN MACHINE.

THE principle of the pin machine is to keep the crank stationary while the tool or tools travel round it. This will at once be understood by a reference to the perspective view, Fig. 1, and the outline, Fig. 2, which illustrate the machine made by Messrs. Craven Brothers, of Manchester, for the Mersey Forge Company. The views represent different sides of the machine, Fig. 2 being the working side, or the side on which the man obtains access to the tools and adjusts them. There are two tool rests, which are mounted on a rotating ring, and are carried round by it. The rests are made deep, but as narrow as possible, to provide the greatest clearance

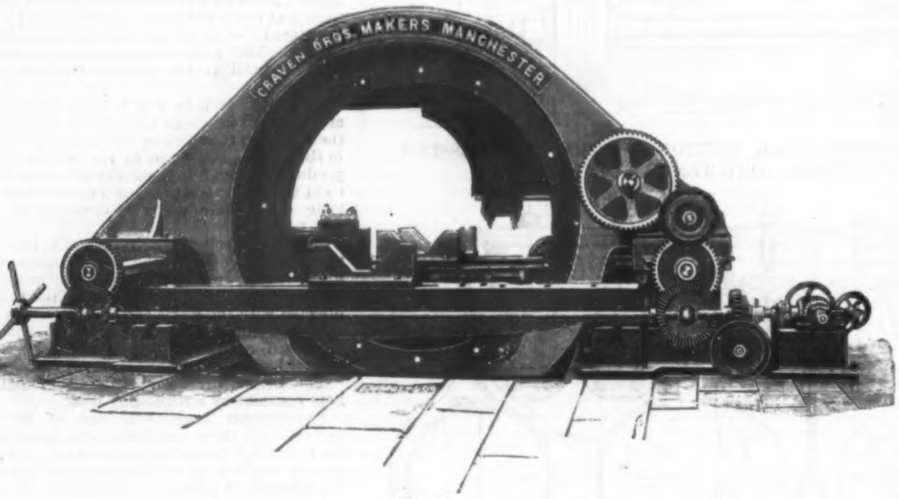


FIG. 1.

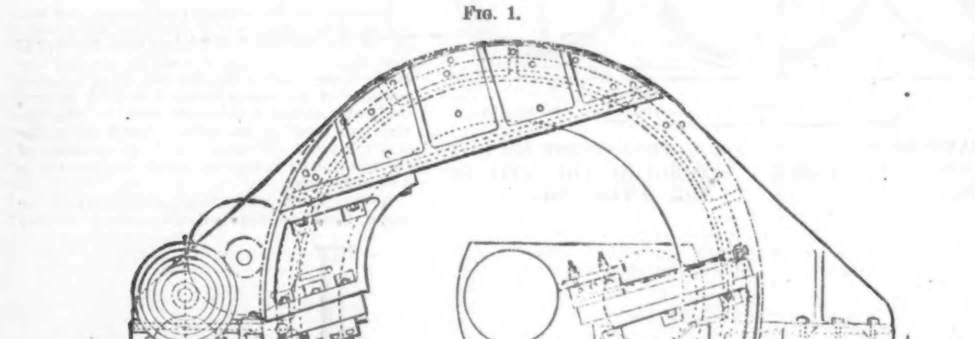


FIG. 2.

PIN-TURNING MACHINE FOR MARINE CRANKS.

as it passes between the webs of the cranks. The tools may be fed up radially and self-acting, if necessary, by the star wheel on their outer ends, for the purpose of facing up the insides of the webs. The same screws also adjust the cut for the diameter of the pin. The rotating ring turns on a large bearing, the wear of which may be taken up by adjustable segments and set-screws. This bearing is a part of the strong circular casting upon which appears the maker's name. For the longitudinal feed the rest-ring and its bearing are slided upon two beds—one on each hand. The motion for the longitudinal traverse may be worked by hand, or self-acting in either direction when turning. It may also be traversed rapidly by power in either direction when the ring is standing, for the purpose of quickly making adjustments. The crank-shaft is supported and bolted down into four V blocks, carried, as seen, on cross girders, of which there are two on each side of the ring. The outside V blocks are adjustable simultaneously with screws, therefore they are always kept in line with each other and parallel to the axis of the machine. In setting the crank two points only have to be attended to—the center line of the crank-shaft must be parallel to the center line of the machine, and at a distance from it equal to half the stroke. This, of course, brings the crank-pin to the center of the ring. It will be seen that the setting with the adjustable V blocks becomes a very easy matter. There is a mark on the cross girders that indicates the center of machine, and by moving the V blocks, so that the vertical center line of the V's is a certain distance (half the stroke) to one side of the marks on cross girders, the turner is perfectly sure that when the pin is turned the crank is of the right throw. When the shaft has two cranks at right angles, this procedure affords great advantages in the accuracy and facility of setting. One crank-pin and the inside of its webs being finished, the bolts are slackened, the other crank brought horizontal, tightened down, and the pin turned as before; then, whatever be the diameter of the body of the shaft, and whether rough-turned or finished, the throw of both cranks must be exactly alike. The inner V blocks and cross girders are merely for supporting the shaft at the point of greatest weakness—each side of the webs. To give an idea of the size of the machine illustrated, the internal diameter of the rotary ring is 9 ft., the total weight is about 31 tons, and it is capable of turning and finishing cranks up to 27 in. diameter and 6 ft. stroke. The machine is a very powerful one, and Mr. O'Connor assures us that he has taken six inches off the diameter of a crank-pin in one traverse up. This is accomplished by using the two tool holders at once, and dividing the cut between them, each taking a cut $1\frac{1}{4}$ in. deep. We have not exhausted our list of the capabilities of the above machine. It may also be used for facing up the outside of the crank-webs, for the ends of the webs, and also for the body part of the shaft—in fact, finishing the crank all over with the exception of the flats of the webs.—*Mechanical World.*

ON THE FORGING AND FINISHING OF MARINE CRANK-SHAFTS.*

IN bringing before your notice the subject of forging and finishing marine crank-shafts, it is not my desire to raise any question as between iron and steel, or which is the best mode of making marine crank-shafts, solid or built, but merely to give you a description of my own practice in forging and finishing marine cranks. Fig. 1 shows how the piece begins from the stave in the usual way, with slabs all welded on the flat, until a base is formed for the building up of the crank. A portion is roughly rounded to form one end of the shaft; then the butt of the crank will present the appearance of a slightly elongated square, as shown at BEG (Fig. 2). The workman then "scarfs" or hollows it down on one edge all along the side, as shown in Fig. 3, from A to B, and as indicated on the end view (Fig. 2) by the dotted line from C to D. It will then present the appearance shown by the end view. Fig. 3, being somewhat bulged outward at the edges of the hollow, shows three long thin slabs forged and shaped for the purpose, and then placed on the hollowed part, the piece lying flat in the furnace. Fig. 4 represents the slabs thus placed in elevation, and Fig. 5 in the section. The slabs are tapered a little, not in length but in cross-section, and little pieces of iron are intercepted between them to keep the surfaces apart and allow the flame free access between them. The object of making them thin is that they may be all equally heated, which is not so readily achieved when the slabs are thick; and the object of the tapering is to allow the slag to flow out freely when the uppermost slab is struck by the steam hammer. The surfaces thus get solidly welded. The slabs are forged long enough to go right across the whole width of the crank, excepting about 6 in., this margin being necessary to allow of the lengthening out of the slab to the whole width under the process of forging. After these slabs are perfectly welded the piece is turned upside down, and the process is repeated on the other side, as shown in Fig. 6. When welded down, and the piece has increased in depth as well, another scarfing takes place on the first side and another on the second side, as shown in Figs. 7 and 8, and so on until the full size is obtained. As will be seen in Fig. 9, by this process of scarfing equally from both sides the iron from the very middle

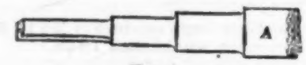


FIG. 1.

of the body of the shaft originally, as at EF (Fig. 2), is drawn up quickly to the crank-pin. The pin will show in section as the dotted line in Fig 9, and it will be seen that by no possibility can there be a scarf end in the crank-pin, as the slabs in all cases go right across the crank, and also that the cheeks of the crank have no edge weldings crossing them. The fiber is also developed by the continuous drawing-out of the iron, consequent upon the repeated flat scarfing across the whole width of the crank. When the crank has been thus massed sufficiently, material left to piece out

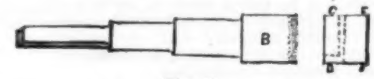


FIG. 2.

the other body of the shaft, this is now done, the coupling welded on, and a small stave drawn on the end, to enable the forgeman to manipulate it when it is turned end to end to complete the other end, as shown in Fig. 10. The crank being welded wholly on the flat must tend to form a more solid forging than if hammered otherwise. Thus, if the forging is well heated and properly hammered, the system promises to insure that no weak part will be found in the shaft after it is finished and put to work. From the success which has already followed in every case the adoption of

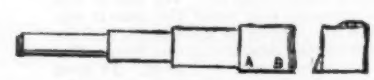


FIG. 3.

this method, the writer believes that .. will eventually be found that almost more depends on the mode on which a crank-shaft forging is constructed than on the material of which it is made. This leads the writer to make some observations regarding the material for such crank-shafts. The great quantity of scrap that finds its way into forges is the shipyard scrap—and the best of selected scrap, to say the least of it, is uncertain; and owing to the varying qualities of iron we are so liable to get, we cannot insure a material of uniform quality, but often find seams or black marks,

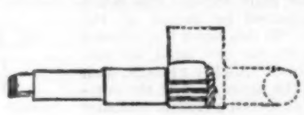


FIG. 4.

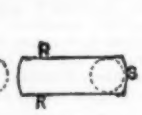


FIG. 9.

which are by so many engineers considered sufficient to condemn almost any finished shafting. So constantly does this occur that it causes us to make such forgings of new iron puddle direct from the pig, and then hammered under the steam hammer into square billet, which is afterward reheated and rolled in the rolling mill into flat bar $\frac{7}{8}$ in. by $4\frac{1}{2}$ in., and this when cut up into proper lengths, and again piled and shingled into the slab, results in a material possessing somewhat the clearness and density of steel, while retaining all the toughness and tenacity of superior malle-

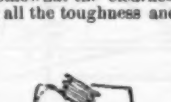


FIG. 5.

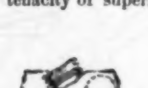


FIG. 6.

able iron. By this means the forging is free from the streaks and seams of the scrap iron. Some forge masters think this freedom in using new iron is acquired at the expense of strength. I do not think so, for by using cold blast iron the crystals would be as fine and as small as in steel. I have cut pieces from crank-shafts made with cold blast pig iron properly worked—that is, several times worked before being put into the shaft—and given them a twisting test with good results. For the twisting tests, the pieces were drawn to $2\frac{1}{4}$ in. square, then turned down to $1\frac{1}{2}$ in. diameter, length

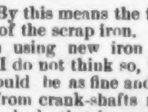


FIG. 7.

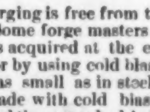


FIG. 8.

of 2 ft. fastened in a lathe by the dog-chuck and firmly secured; the lathe was then turned slowly round, and sheared the sample off at four and a half turns. Of this improved iron are made at the Mersey Forge the cranks that many of the large ship-owners are using, viz., the National, the Cunard, the Inman, and other companies. The shaft in photograph before you was made of this iron. For extra large crank-shafts the fear of unsoundness arising from the ordinary mode of forging has led some engineers to consider the propriety of building the cranks in separate pieces. One

* Paper read by Mr. O'Connor, of the Mersey Forge Company, Limited, Liverpool, before the Manchester Association of Employers, Foremen, and Draughtsmen.

advantage of the built crank-shaft is, that should there be a flaw it may be confined to one part only, whereas in a solid crank-shaft it may necessitate the condemnation of the entire crank-shaft. My impression is that large shafts will still have to be dealt with in pieces, not because it is a question of being able to make large forgings sound, but the difficulty arising from the fact that no marine engineer could run the risk of anything going wrong with large shafts, and ships having to wait until another could be finished. This is the difficulty to be encountered in dealing with forgings of ex-

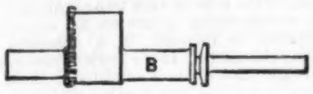


FIG. 10.

cessive size. The built crank-shaft will be 25 per cent. heavier than a solid crank-shaft; moreover, the increased weight necessitated by separate building is viewed as a disadvantage, although it is not attended with much greater cost. Perhaps it would be unwise for me to pass any opinion as to whether a built-up shaft or a solid shaft is the better, but I am quite certain the Mersey Forge Company will be most happy to make either. The building up of large shafts with capable tools presents no difficulty whatever. One firm with which I was once connected turned out a ship with

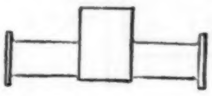


FIG. 11.

a crank-shaft 58 tons weight. It was built up in fifteen independent pieces, every crank web was separate, the crank-pin was another portion, and the two ends were also separate, which are shown in model. Three such cranks constituted the crank-shaft of the ship Arizona. In the mechanical engineering of the future we can rely more on our tools for putting large pieces together much better than had been done formerly, and I should find no difficulty in dealing with crank-shafts up to 100 tons, which I think will have to be made within the next few years. I will now explain the

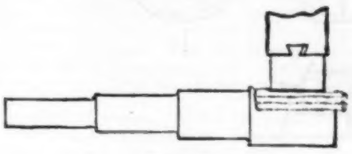
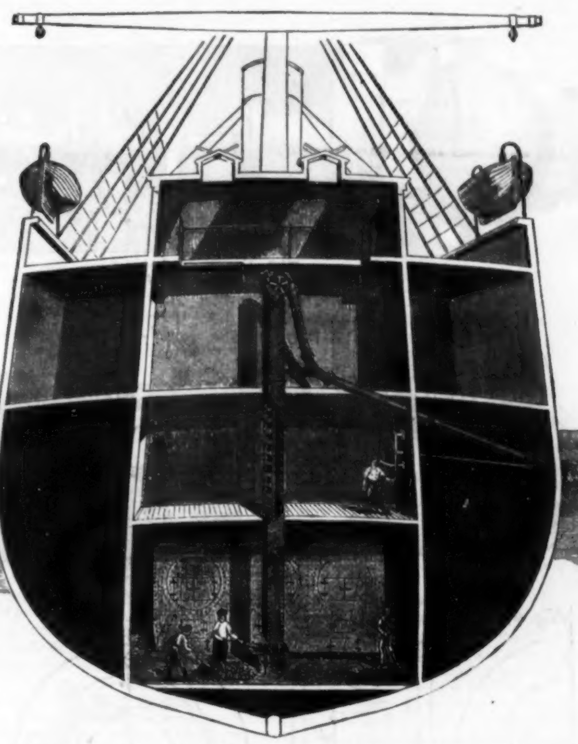


FIG. 12.

finishing of solid crank-shafts. First, the crank is marked out to the drawing, to see that the shaft will turn to the required size, then it is put in the slotting machine and cut two grooves at same time, and then the piece between these two grooves is afterward wedged out to make room for the tool to slot out the other end portion as shown, in model. The crank is then rough-turned to a quarter inch above finished size, and then placed in a planing machine, in which are planed the flat and the crown of crank at the same time. The crown is planed by a tool in a rest carried on the upright of the planing machine. The tool-box of this is controlled by a radius bar, and can be set to plane the crown to any desired curve at the same time as the flat is planed. The crank is then turned over, and the other flat and crown finished in the same way. There is with this machine a decided economy in time and an extra centering and balancing in the lathe. The crank is then taken to have the crank-pin turned, a process which will illustrate the large quantity of metal to be cut away before the pin is rounded. For this purpose there is a special machine, which finishes the pin, the crank being stationary and the tools revolving. With this machine it is possible to reduce a crank-pin 6 in. in diameter with one cut. Another advantage in this machine over the old plan of turning crank-pins is the saving of time in not having to balance the crank, thus insuring perfect roundness of the crank-pin, which was a difficulty in the old system of turning the marine crank-shaft in the lathe. In the case of a pair of cranks coupled together, the sides of webs and one coupling of each crank are finished, the holes for bolting together are bored, and after this they are bolted together, put in the lathe, and both cranks finished at the same time, which causes them to be perfectly true and ready for the sole-plate of the engine. The built crank consists of five pieces, viz., two webs, one crank-pin, and two pieces for body of shaft, to finish which the two webs are planed to the requisite thickness, then bored, the end for body of shaft being finished to the size, and the other end rough-bored to quarter of an inch of finished size. The webs are then slotted to the required shape and size, and the keyways are cut in the finished holes. The body parts are rough-turned to quarter of an inch finished size, and the parts that fit into the webs are finished to the size for shrinking into them on the body parts. The keyways are now cut to correspond with the keyways of the webs, then the body of shaft is inserted, and the keys are fitted in. The crank is now ready for the horizontal boring machine, by which the crank-pin holes are bored. As you will perceive from the model, by the mode of centering I adopt, and the boring of the holes in both crank-webs, with the same setting, and by the same boring bar, I arrive at the strictest accuracy. When finished, the crank is not removed at once from this machine, and for the purpose of shrinking in the finished pin a wood fire is built round the webs, the pin is in readiness slung in the crane, and when the webs are sufficiently expanded the pin is immediately adjusted in its place, which requires great care and promptitude, for if the pin were to catch hold before getting in its place there would be a great sacrifice of labor, as it could not probably be got out without being bored away. There is no water used for cooling, as I have found this practice is not so good and effective as to let it cool down naturally and regain its former shape. The crank is now put in the lathe, and the pin being finished before shrinking in, the body of the shaft is turned, and the pin is ascertained to be perfectly true to the body of shaft. This mode of boring the crank-pin hole in centers, which you observe by the model, enables me to say, without any fear, that all parts could be finished separately before shrinking together and to be perfectly true. For instance, in a built crank which has been worked, and the pin becoming defective or broken, I could replace it with a new pin or any other part which might be required to replace a defective one, and it will be as perfectly true as when first made. In large crank-shafts this would be found an immense saving and advantage. Taking into consideration the vastly accelerated speed of the marine engine in late years, and the many disastrous effects which follow the breaking of a shaft at sea, also that the tendency of the age is still toward much higher pressures of steam and further lengthening of stroke, it is not surprising that improvements in such an important part as the crank-shaft should be eagerly sought after, but it has hitherto been sought in the direction of material alone. Cast steel has been advocated and brought to some extent into use, but its expense renders such shafts costly out of all proportion to other parts of the engine, while in the event of their heating when at work (a very frequent casualty), and having the water-hose directed upon the crank-pin or journals, it cannot be expected that the material will behave any better than or even as well as tough wrought iron. In my experience steel shafts have broken very suddenly without giving any previous warning, and others have exhibited some very slight marks or cracks, after which it was not considered safe to work them a day longer. Now, an iron shaft will show some flaw or mark before it breaks; these flaws may be watched, and can be traced from time to time, and thus sufficient warning is given to enable the necessary repair to be put in hand and got ready without causing any delay. It is certainly far better that a forging should give notice rather than fail suddenly. Having made no reference to the cause of the breaking of crank-shafts, I will state my opinion on this point. It is not in all cases the fault of the material, steel or iron, or the manufacture. All know that marine crank-shafts are exposed to very severe, uncertain, and unequal strains. If the shaft bearings were not properly true—and in many cases the bearings would work unequally—there was a strain thrown on the shaft which tended to shorten its life. It was only a question of time as to when a marine engine crank or a locomotive crank would break. Again, cranks were very often permitted to run with slack bearings. Supposing an engine to be making 120 strokes or knocks to the minute on the iron of a crank-shaft, this tends to destroy the fiber and render it crystalline, which is not healthy for the shaft, and its giving way becomes only a question of time. The thrust of a shaft, if not properly attended to, brings a side action upon the afterweb of the crank, which tends to bend it backward and forward, and in course of time a fracture occurs either at the neck of the journal or through the web of the crank.

AN IMPROVED ASH-HOIST FOR STEAMSHIPS.

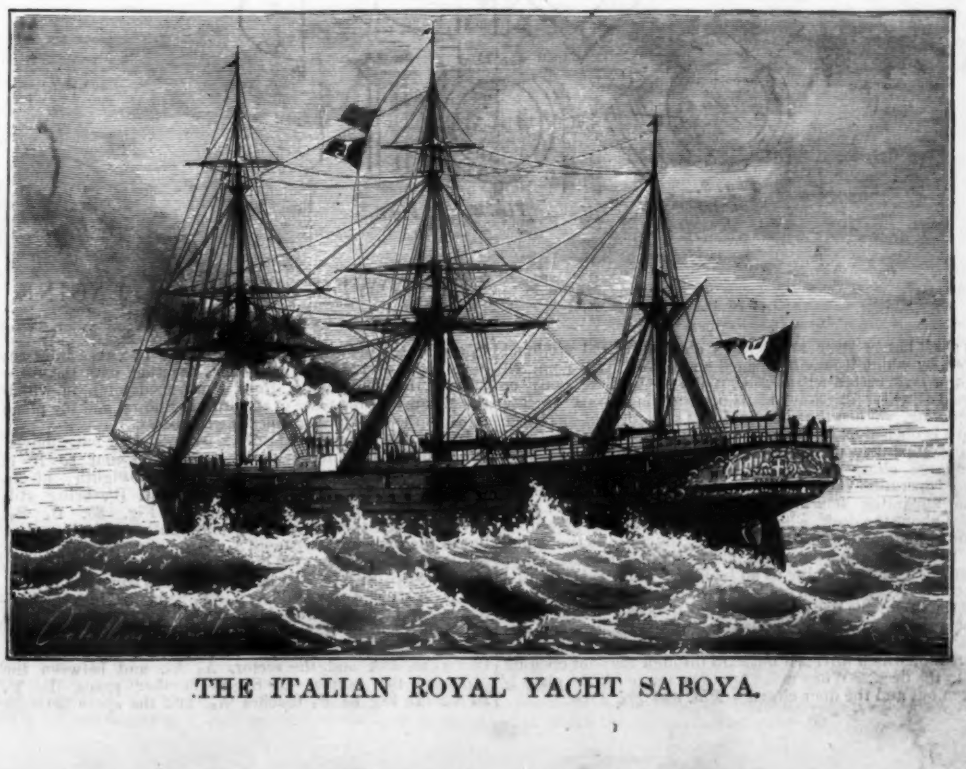
ON the steamers Alameda and Mariposa, which run between San Francisco and Honolulu, on the Oceanic Steamship Company's line, an improved device has been adopted for raising the ashes from the fire-room and passing them overboard, without any handling at all, invented by Mr. John D. Spreckels, one of the principal owners in the line, and the senior of the firm acting as agents.



IMPROVED ASH HOISTING AND DISCHARGING APPARATUS FOR STEAMSHIPS.

On the hearth of the fire-room is an iron receiver into which the ashes are dumped. The refuse from the fire-room at the opposite end of the boilers is brought in iron buckets, such as are used for passing coal, and which are suspended by chains from rollers which run on rails above, as the engraving shows. The ashes are dumped on the iron floor and wet down so as to cool them and prevent them from injuring the elevator belt, after which they are raked into the receiver whenever they accumulate so as to be inconvenient.

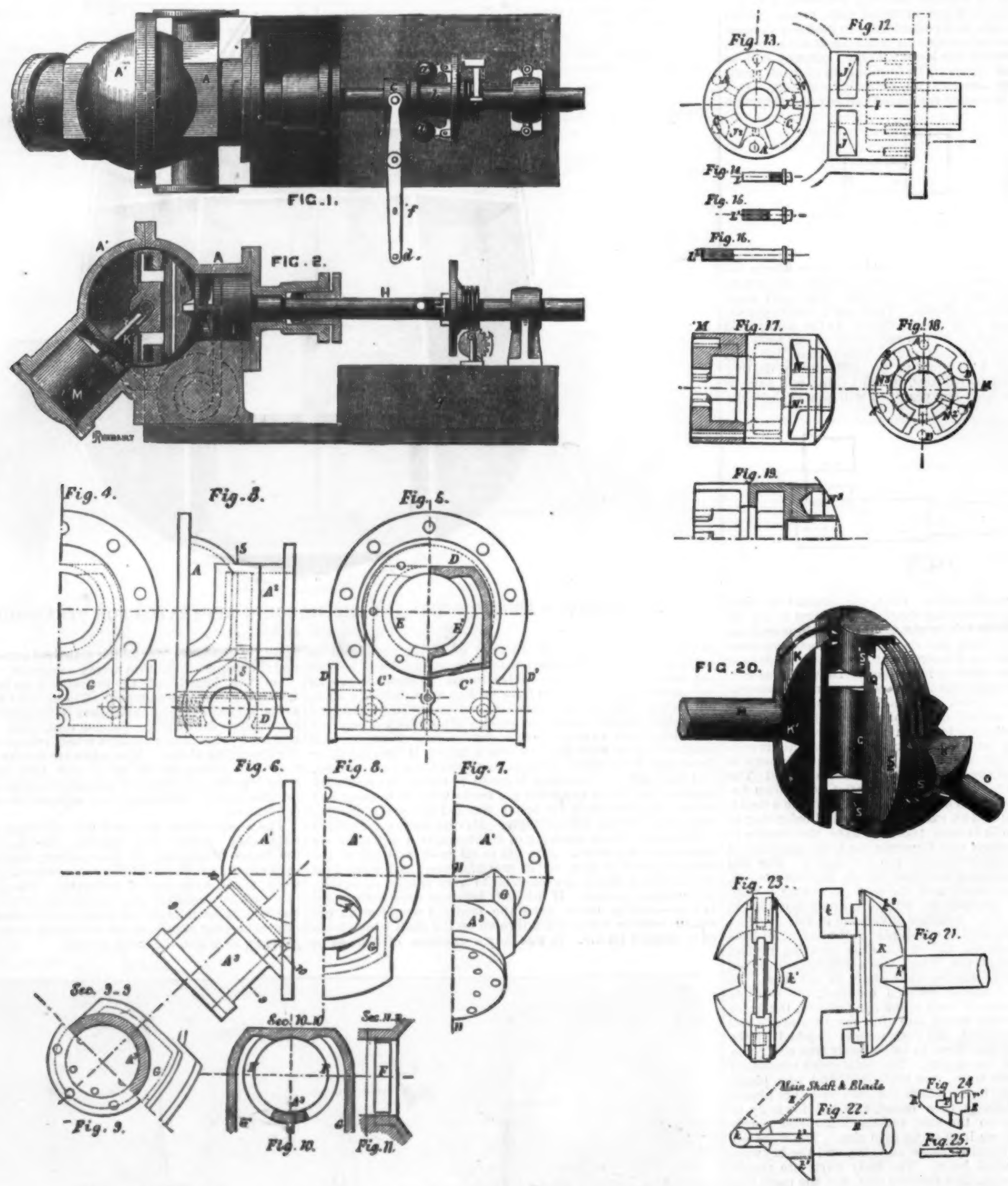
The receiver is so arranged that the tension of the belt is adjustable. As the belt revolves, the buckets scoop up the ashes deposited in the receiver, carrying them to the upper deck, where they fall into a chute-pipe leading downward to the water-line of the vessel. The power to operate the belt is a small engine on the side of the casing, which receives its steam from the main boilers of the steamer. The gear wheel for revolving the belt-drum is shown in the engraving, as is also the small engine.



THE ITALIAN ROYAL YACHT SABOYA.

The upper end of the discharge chute or pipe has a hood extending upward, and curving partially over the upper bucket roller, so as to insure the discharge of the contents of the buckets into the chute without scattering. The chute extends down through the second deck in a nearly vertical position, and below the deck it curves so as to assume a more nearly horizontal position and pass out through the side of the vessel, thus obstructing the interior space to the least extent. As the material is apt to clog when discharged through this chute, an opening or passage is made into it, entering on a line with the direction of the lower portion, and a water pipe, as shown, connects with it, with a valve, through which a body of water from the pump may be discharged through the pipe, and forcibly clear it or prevent any lodgment of material within it.

A gate is fitted into the discharge chute, near its outer end, and serves to close it when not in use, preventing ingress of of water. This valve or gate swings in a chamber of somewhat larger diameter than the rest of the pipe, so that when it is open it is out of the way and leaves a clear passage. Its shaft has a lever arm with a connecting rod and hand lever, by which it may be opened and closed, and a curved link or rack with a set screw or pawl to hold it open or closed at will. The way this is operated is shown in the engraving. When the little engine is started, the discharge valve is opened and a stream of water turned into said discharge pipe. As the ashes are hoisted and dumped into the discharge chute they are quickly forced overboard, the whole operation being performed quickly and without noise. The apparatus is also utilized for another purpose. At a point above the deck, where the donkey boiler is placed, a door is made, and a plate is fitted into the chute so that when in place it extends upward and backward from the lower edge of the door opening as an incline. This device is used whenever it is desired to hoist coal from the fire-room bunkers for the use of the donkey boiler; and the coal, being taken from the receiver, is carried up by the buckets and discharged into the chute, flowing down the inclined plate referred to, which directs it outward through the door opening on to the deck. When ashes are to be removed, the plate is taken out and the door closed.—*Min. and Sci. Press.*



THE TOWER SPHERICAL ENGINE.

THE TOWER SPHERICAL ENGINE.

We will first endeavor to make clear the geometrical principle upon which it is founded. Its elemental parts are two sectors of spheres, the angle of whose planes is 90 deg., and a disk of infinitesimal thickness. Suppose these parts to be placed in conjunction, as shown in Fig. 33, *i. e.*, with the lines of intersection of the planes of one sector hinged to one diameter of the disk, and the corresponding edge of the other sector hinged to another diameter of the disk at the opposite side, and at right angles to the former. The edges of the sectors are lettered, A^1 A^2, B^1 B^2, respectively, the last letter being hidden in Fig. 33, and the disk appearing as a straight line, because its infinitely thin edge is presented to the spectator. In Figs. 33, 34, 35, and 36 the combination of plane and sectors is followed through half a complete revolution, and the relative positions of the various parts are shown as they appear at each eighth revolution. One sector rotates on an axis, D, lying in the plane of the paper, and extending to the center of the sphere, and the other on a similar axis, C, also in the plane of the paper. The two axes intersect at an angle of 135 deg., and they, together with the three parts of the combination, form a universal joint, in which the sectors take the place of the ordinary bows, and the plane replaces the crosspiece connecting the bows.

In Fig. 34, the sector, A^1 A^2, is supposed to have moved one-eighth of a revolution about its axis, C, and B^1 B^2 is supposed to have moved through one-eighth of a revolution about its axis, D, the point, B^2, being still behind the system and invisible. In Fig. 35, B_1 B_2, having moved through another one-eighth revolution, now lies in the plane of the paper, A_2 is presented to view and A_1 is away from view; the disk is again seen as only a right line, now, B_1 B_2. In Fig. 36, B_1 B_2 is seen from end to end, and A_2 is the end visible of A_1 A_2, A_1 being behind the system. After another one-eighth revolution, B_2 will have taken the place of B_1 and A_2 of A_1 in Fig. 33.

Referring to Fig. 34, a space, A_1 E_1 A_2 B_1, will be seen between the disk and the sector, A_1 A_2, and between the disk and the sector, B_1 B_2, is another space, B_1 F_2 B_2 A_2. In Fig. 33, F_2 touches A_2, and the space between the side of the sector and the disk is *nil*. In the transition from Fig. 33 to Fig. 34 both spaces have been increased. In Fig. 35, A_1 E_1 A_2 B_2 has opened to its full width, and B_1 F_2 B_2 A_2 is still opening. In Fig. 36, A_1 E_1 A_2 B_1 (behind the system) is closing, and another space, A_2 E_2 A_1 B_2, is opening. The space, B_1 F_2 B_2 A_2, is also opening, and becomes full open when the system takes the form of Fig. 33, but with the points reversed, as before described. We have now traced the effect of half a revolution of the system; another half revolution will be a reproduction of the first.

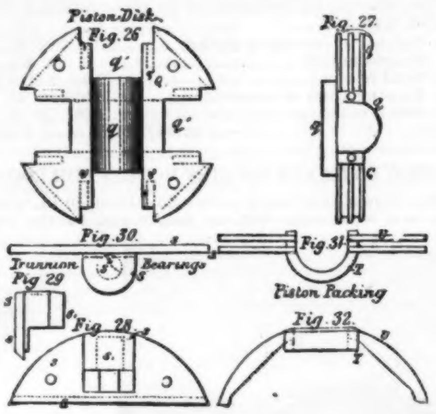
It is seen, therefore, that the system in revolving continually presents on the side on view two expanding spaces, and two closing or contracting spaces on the opposite side. If this combination be inclosed in a spherical shell, the spaces become chambers. In the engine these chambers are made steam-tight, and steam is admitted to them when they are increasing or opening, and is exhausted from them when they commence to contract or close. In the engine in its practical form the sectors are slightly altered, as to the position of their circumscribing surfaces, to enable the disk to be of real thickness instead of a thin plane, as shown in the elementary diagram.

The details of the ports and passages for admission and emission of steam, and of the connections between the sectors (called in practice blades) and the plane or piston, are shown in Figs. 1 to 32, in which Fig. 1 shows a plan of the complete engine, and Fig. 2 a longitudinal section of the same.

The spherical casing, A A^1, is divided at right angles to the axis of the driving shaft, the part, A, through which the driving shaft passes being bolted to the bed-plate, B, while the part, A^1, carrying the dummy shaft is bolted to A. The part, A, is formed with steam and exhaust chests, C C^1, shown more clearly in the detached views of the half-casing at Figs. 3, 4, and 5, in which Fig. 3 shows a side view, Fig. 4 a part front end view, and Fig. 5 a back end view, partly in section on line 5—5, Fig. 3. These chests communicate, first, with the steam and exhaust pipes by branches, D D_1, and, secondly, with the interior of the cylindrical extension, A^2, of A by the ports, E E^1. The chests, C C^1, also communicate with the ports, F F^1, in the cylindrical extension,

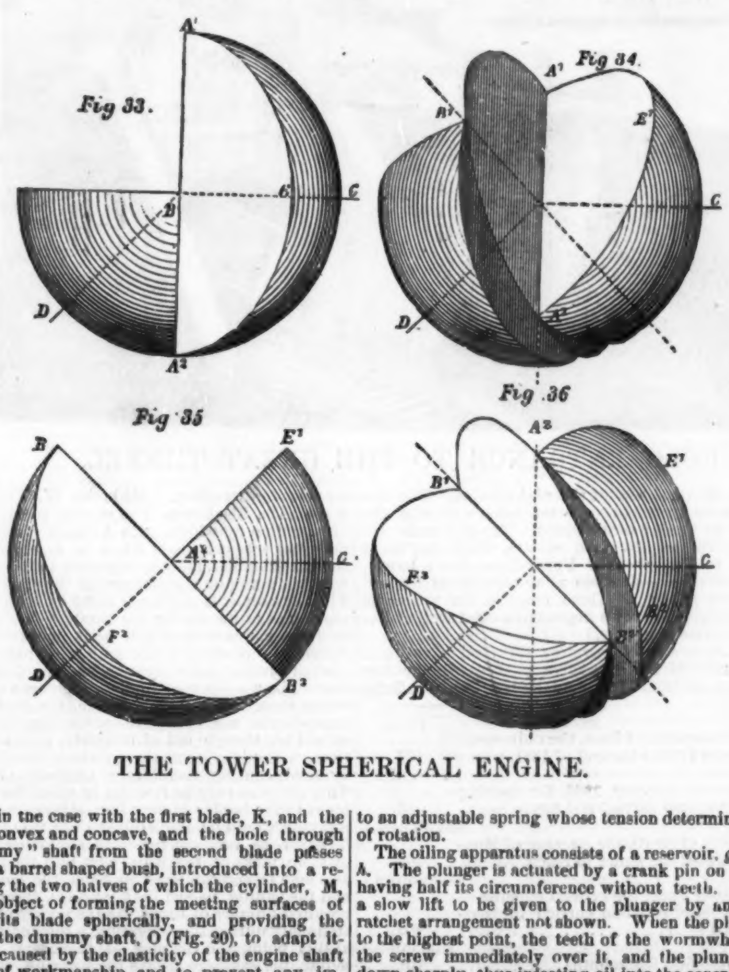
A^2, of the half-casing, A^1, by means of the passages, G G^1, formed partly in A and partly in A^1. The part, A^1, is shown detached in Figs. 6 to 11, in which Fig. 6 shows a side view, Fig. 7 part front view, and Fig. 8 a part back view, while Figs. 9, 10, and 11 show sections taken respectively on lines 9—9, 10—10, and 11—11.

The cylindrical extension, A^2, of A, is closed at its outer end by a cover and stuffing-box, through which the engine shaft, H, passes (Fig. 2), and it has fitted accurately within it a cylinder, I, shown detached in side and end views at Figs. 12 and 13, in which are formed passages, J^1 J^1, having ports at the sides corresponding with the port, E, of the casing, and also a port, J^2, on the flat inner face. There is also a corresponding passage from E^1 to J^2 on the same face, which fits against the circular flat face of the main blade, K (Figs. 21, 22, and 23), to be presently described, these circular flat faces being made to correspond with the plane of intersection of the interior of the cylinder, A^2, with that of the sphere, A. Thus the steam passing from the steam chest, C^1, will find its



way through the passage and port, J^2, into the spherical casing whenever the port is uncovered by the notches, k^1, of the blade, K (Fig. 22), and the exhaust will in like manner pass from A through the port, J^2, passage, J^1, and the exhaust chest, C^1. The flat face of the blade, K, with its notches, consequently acts as a valve face relatively to the ports, J^1 J^2, and the two faces are kept in close contact, by means of push screws, L, Fig. 14, passing through the cylinder cover, and pressing the cylinder, I, against the valve face, pull screws, L^1, Fig. 15, being provided to lock the cylinder, I.

The cylindrical extension, A^3, of A^1 is similarly provided with a cylinder, M, shown detached in part sectional side view at Fig. 17, in end view at Fig. 18, and in part section at right angles to Fig. 17 at Fig. 19. In this cylinder are formed steam and exhaust passages, N N^1, having side apertures corresponding with the ports, F F^1, of the casing, and having ports, N^2 N^2, on the inner face of the cylinder, which bears against the face of the second blade. These faces are



THE TOWER SPHERICAL ENGINE.

not made flat, as in the case with the first blade, K, and the cylinder, I, but convex and concave, and the hole through which the "dummy" shaft from the second blade passes is provided with a barrel shaped bush, introduced into a recess by separating the two halves of which the cylinder, M, is formed. The object of forming the meeting surfaces of this cylinder and its blade spherically, and providing the bush, is to allow the dummy shaft, O (Fig. 20), to adapt itself to deviations caused by the elasticity of the engine shaft or imperfections of workmanship, and to prevent any imperfect contact between the meeting faces of M and K in consequence of such deviations. The surface of the blade with its notches, working against the face of M, acts as a valve face, similarly to the blade, K, for alternately admitting steam through the port, N^2, and exhausting it therefrom through the port, N^2. The cylinder, M, is for this purpose kept steam tight against K^1 by push screws, L, Fig. 14,

and is locked by pull screws, L^2, Fig. 16. The piston, Q, and blades, K K^1, with engine shaft, H, and dummy shaft, O, are shown combined in perspective at Fig. 20, and detached at Figs. 21 to 27. Figs. 21, 22, and 23 show respectively a side view, a plan, and an end view of the blade, K; the second blade, K^1, differs only in its valve face being concave. The blade, K, and shaft, H, as also the blade, K^1, and shaft, O, are each made of one solid piece of steel, the blades having their sides beveled, as shown, to correspond with the inclinations of the piston, Q, in the one direction and the other during its revolution. The blades have projecting trunnion pins, *k* (Fig. 21), forming the cross axes of the movement, which trunnions fits into brasses, S (Figs 20, 28, and 30), attached to the piston, Q. The blades have, furthermore, notches, k^1, on each side, which, as the blades revolve, come respectively opposite the ports, J^1 J^2 (Fig. 13), and N^2 N^2 (Fig. 18), so as to put the spaces between the blades and the piston alternately in communication with the steam supply and the exhaust. The blades are made to work the steam tight against the spherical casing by means of packing pieces, R R^1, shown in side and end views at Figs. 24 and 25, which fit into deep grooves in the blade. The parts, R R^1, overlap each other as shown, and slide upon each other with curved surfaces at F, so that while R is pressed outward by a spring at r^1, and R^1 is pressed in a direction at right angles thereto by a second spring, their outer packing edges will always form a continuous circular curvature. The part, R^1, fits with its notched surface againts the packing piece, T (Fig. 31), for the brasses, S, of the trunnion, *k*. The blades, K K^1, have, furthermore, grooves at k^2 (Fig. 21), into which are fitted packing pieces working against the cylindrical parts, *q*, formed on the piston, Q. This piston, which is shown detached in front and side view at Figs. 26 and 27, has four gaps, q^1, into which fit the before mentioned brasses, S, shown in front view, side view, and end view at Figs. 28, 29, and 30, and in perspective at Fig. 20. These brasses consist of a plate, *s*, which is secured by screws to the piston itself, and of a cylindrical part, s^1, formed on the plate, and fitting with flat sides into the gaps, q^1. The axes of the holes, s^2, of the brasses coincide with the central cross axes of the piston itself.

The piston is made to work steam-tight against the spherical surface of the casing by means of curved packing pieces, U, Figs. 31 and 32, fitting into grooves formed on the edge of the piston, while *horseshoe* packing pieces, T, fit round the bearings, S. Small springs in recesses at q^2 in the piston press these pieces, T, outward, and the pieces, U, being notched into the pieces, T, are consequently also pressed outward thereby.

As one of the notches, *k*, of the blades, K K^1, passes respectively over the ports, J^2 and N^2, steam will be admitted to those chambers between the blades and pistons, which, for the time being, are enlarging, the pressure of the steam effecting such enlargement, and thereby producing the rotation of the engine shaft. When the notch, *k*, has passed the edge of the port, expansion will take place, until, by the rotation of the blade, the notch, *k*, is brought opposite the exhaust port, J^2 or N^2, whereupon the chamber will be exhausted.

On the extreme right of Figs. 1 and 2 are shown the governor and oiling apparatus. The governor balls, *a a*, when extended by centrifugal force cause the collar, *b*, to traverse horizontally, and to press against the collar, *c*. This is embraced by the forked end of the lever, *d d*, pivoted at *e*. This lever is connected at *f* to the throttle valve, and at d^1 to an adjustable spring whose tension determines the speed of rotation.

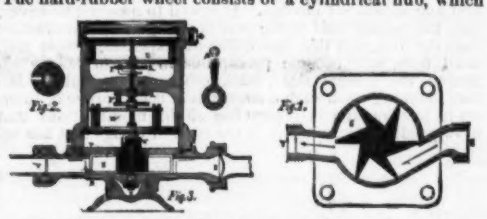
The oiling apparatus consists of a reservoir, *g*, and a pump *h*. The plunger is actuated by a crank pin on a wormwheel having half its circumference without teeth. This enables a slow lift to be given to the plunger by an intermittent ratchet arrangement not shown. When the plunger is lifted to the highest point, the teeth of the wormwheel gear with the screw immediately over it, and the plunger is pushed down sharply, thus injecting oil into the several channels in the engine itself, through which it has to be made to pass.

The patent rights of this engine are held by Messrs. Heenan and Froude, who are laying down special machinery in their works at Manchester for its rapid and accurate construction. No engine yet made gives so great a result in foot-pounds per revolution for its size and weight, while its capacity for running at very high speeds recommends it to the electrician as by its use he can obtain an immense amount of energy from a comparatively small dynamo without the use of intermediate gearing. For ship lighting the advantage of this point is most evident.—*Engineering.*

DREYER, ROSENKRANZ, AND DROOP'S WATER METER.

THE accompanying figures illustrate a water meter invented and manufactured by Messrs. Dreyer, Rosenkranz, and Droop, of Hanover. Fig. 1 shows the apparatus in section, and Fig. 2 gives a plan of the lower part of the apparatus containing the measuring wheel. The three principal parts of the meter are: (1) a cavity at the bottom carrying the pivot upon which the measuring wheel revolves; (2) a hard-rubber wheel; and (3) a cap for covering the transmitting and measuring mechanism.

A is a short cylindrical reservoir having for its bottom the base, B, and for its top the disk, P. In the center of this reservoir there is arranged a vertical axle, X, which constitutes the pivot upon which revolves the wheel, S. The water enters the reservoir, A, tangentially at E, and makes its exit at V. The wheel, S, fills the empty part of the reservoir, wherein it is capable of revolving without friction. The hard-rubber wheel consists of a cylindrical hub, which



DREYER, ROSENKRANZ & DROOP'S WATER METER.

prevents the water from passing directly from E to V, while its teeth, being acted upon by the water, set the wheel in motion. The upper part, W, of the hub serves to transmit motion to the registering apparatus. For this purpose, a crank, *p*, is made to revolve the transmitting mechanism, *u*, which acts through the crank, P^1, upon the lower wheel, R, keyed to the axle, *d*. This latter, in its turn, carries along the upper wheel, R, and the registering mechanism, Z, by means of the crank, P^2. Fig. 2 shows one of these wheels, R.

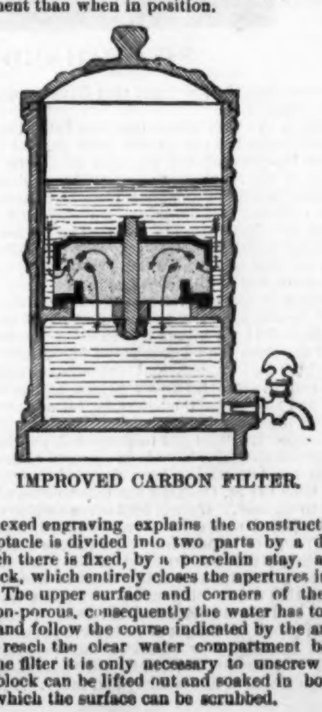
Such meters as are of from 10 to 50 mm. inclusive are of metal; and in those of from 60 to 100 mm. the lower reservoir is also entirely of metal. The advantages of hard rubber consists in its lightness, its resistance to wear, and its inalterability in presence of water. The material is scarcely denser than water, and for this reason rapidly takes on the exact speed of the latter when it is traversing the meter, and even when the cock is but slightly turned on and the pressure is feeble. The inlet and outlet apertures are so large that they cannot become obstructed, and for this reason they remain always the same, and the action of the meter does not vary. Besides this, the water traverses the apparatus with ease, and there results from this less loss of pressure. The meter requires no regulating, since the accuracy of the measuring depends only upon the dimensions of the wheel and those of the passage way, which are invariably fixed.

The apparatus is so simple in structure that it can be taken apart without taking it off the service pipe, by simply unscrewing the screw, *n*, in order to clean it, etc. It can be put together again just as easily. The driving and regulating mechanisms, *u* and Z, are held merely by movable circles, *c*, thus permitting of their being taken out without trouble. The ease with which the taking apart may be effected renders this apparatus very convenient in practice.

The meter contains no oil to render the water foul and to produce verdigris. The principal wheels and the journals of the driving mechanism are likewise of hard rubber, which well resists the action of the water in which these parts have to work. The dial is arranged like that of a gas meter, and is consequently very easily read.—*Bull. Mus. de l'Industrie.*

IMPROVED CARBON FILTER.

THE Silicated Carbon Filter Company, of Battersea, London, have devised a filter which can be taken entirely to pieces, so that every part may be cleaned, while the filtering block can be subjected to much more thorough and searching treatment than when in position.



IMPROVED CARBON FILTER.

The annexed engraving explains the construction. The stone receptacle is divided into two parts by a diaphragm upon which there is fixed, by a porcelain stay, a silicated carbon block, which entirely closes the apertures in the diaphragm. The upper surface and corners of the filtering block is non-porous, consequently the water has to enter at the edges and follow the course indicated by the arrows, before it can reach the clear water compartment below. In cleaning the filter it is only necessary to unscrew the nut, when the block can be lifted out and soaked in boiling water, after which the surface can be scrubbed.

THE ST. GOTHARD RAILROAD.

When, in May, 1883, we published an article on the St. Gothard Railroad, the operating of the entire system was of too recent a date, and the statistics were too few, to make it possible to touch upon certain important questions, and among other things the details as to the cost of operating the line. At present this question, as well as others, has made great strides toward a definite solution—a circumstance that will permit us to supply the deficiencies in our first article.

This taking up of such a subject is, in several respects, a little premature. The year 1882, the last one of which the figures have been compiled, was one of transition, and a comparison between 1883 and the former years would have more value than one that may be made from this day on. But, as the figures for the current year cannot be known till about the middle of 1884, we have judged it well not to wait until then to examine the results of the exploitation of the line that is commanded by the great tunnel and completed by the mountain sections.

The transition, properly so called, occurred, moreover, during the first half of 1882, and the last six or seven months of this same year were already approaching a normal state. It is *à propos*, then, to compare the figures of the first and second six months. It is well to observe, however, that the second half of the year is always more productive than the first, and that the different expenses, almost null until here, will become perceptible in measure as we approach the normal state, while others will diminish. Before touching upon such a comparison it will prove of interest to pass rapidly in review the slight modifications that have gradually been made in the state of things that has before been described, the incidents that have happened, and the present situation.

Let us state in the first place that the intention of abandoning the old route has not as yet been carried out. Andermath and Hospenthal, the junction where the roads of the two sides of the St. Gothard and those of Oberalp unite with each other, continue to possess great attraction. These are summer stations, and the tide of travel thither was very large during the fine season of 1883. The papers teach us that the annual number of travelers who cross the defile in stage coach has dropped from 206,602 to 154,496, and the receipts from 2,669,842 to 2,124,246 francs.

The *personnel* of the general management of the line, stations, trains, traction, and shops amounted, at the end of 1882, to 1,449, or 5·44 per kilometer of the line operated. The *personnel* of the great tunnel consists of one district superintendent, eight road masters and substitutes, eight tunnel watchmen and assistants, two watchmen at the termini of the tunnel, and two station masters, or twenty-one persons all told. The night service is performed by special guards. This organization has been put to the proof, and in all cases where dangerous obstacles have been opposed to the passages of the trains the latter have been signaled in time. Up to the present time the St. Gothard has had no case of accident to travelers to register. During 1882 seven employes or other persons were killed and eight were wounded, nearly all of them as the result of imprudence. As for the accidents that happened during the construction of the road, these occasioned six cases of death and thirty-eight of wounding. As for accidents that did nothing more than delay trains, these were limited to five landslides and six falls of large rocks. Moreover, fifty-one breakages of rails have occurred.

The great tunnel is now 14,984·02 meters (9·25 miles) in length. As well known, it is lined throughout. The bad places have occasioned new anxiety and labor. A few defections have occurred, although they are not of much importance, and it has been found necessary to reconstruct four rings and replace one arch butment.

Out of 24,215·08 meters (15 miles) of tunnels, we find 12,019·08 meters (7·45 miles) entirely lined; 9,600·02 meters (5·95 miles) partially so; and 2,595·08 meters (1·6 miles) without a lining of masonry. As for the tunnels of the Giubiasco-Lugano section, that is to say, the mountainous portion on Mt. Cenere, which form a total of 3,244·09 meters (2 miles), they are lined throughout.

The laying of a double track in certain sections, and particularly in the great tunnel, required by federal authority, has furnished an occasion to make experiments with metallic trackways. In two sections of 500 meters each, the rails have been laid upon stringers of the Hohenegger system. Over a length of 200 meters a system of iron ties, such as applied in Alsace upon the State railways, has been adopted. Finally, 2·3 kilometers have been set apart for experiments in trackways with cross sleepers of different profiles, principally of the small Hilf profile.

The running of the trains was regulated by a conference in which participated representatives of the Gothard, those of the seven German companies, of four Swiss companies, the French Company of the East, and that of Upper Italy, and of Belgium. Basel, through its geographical situation, and Milan, through its importance, were found to be the most marked points of the international line. The direct night trains, French and German, arriving at Basel early in the morning, correspond to an express that leaves at quarter past seven o'clock and reaches Milan at forty-one minutes past seven in the evening. The return express leaves Milan at half past seven in the morning and reaches Basel at thirty-five minutes past seven in the evening, where it corresponds in its turn with the departure of the night trains. The Gothard night express coincides in the same way with the morning trains for foreign destinations. The day trains are made up of cars on the American system, while the night trains use the rolling stock of Upper Italy, that is to say, coaches with side doors—a system more convenient for travelers who desire to sleep. These coaches, for the same number of passengers, likewise represent a dead weight less than that of the American cars.

An *expose* of the results of operating the road necessitates a preliminary *expose* of the successive increases in the line operated. It results from the round figures of the official report that:

	Kilos.
The Ticino system of lines, the only ones operated from 1874 to the end of 1881, was..	67 (41·5 miles.)
On the first of January, 1882, the opening of the great tunnel carried this figure to....	83 (50·5 miles.)
On the 10th of April, the opening of Monte Cenere caused the figure to reach	109 (67·5 miles)
On the 1st of June, the general opening of travel from Basel to Milan carried the system operated to..........	250 (155 miles.)
Mean of the first five months	101 (62·6 miles.)
do. do. six do.	118 (63 miles.)
On the 4th of December the system completed by the opening of the Pino Novare line reached..........	266 (164·9 miles.)

The Company asserts that during the period of construction, from 1874 to June 30, 1882, the excess of receipts over expenditures was 1,195,055 francs and 82 centimes, while the estimate had carried it to 500,000 francs only.

	Receipts.	Expenditures.
In 1882, the six months ending June 30, gave ..	1,140,423·10 fr.	658,667·97 fr.
The travelers, including baggage, entered this figure for...........56·87%.		
The six months ending December 31, gave	5,686,074·71 "	2,166,376·97
The travelers, with their baggage, represent in the receipts...........45·38%		

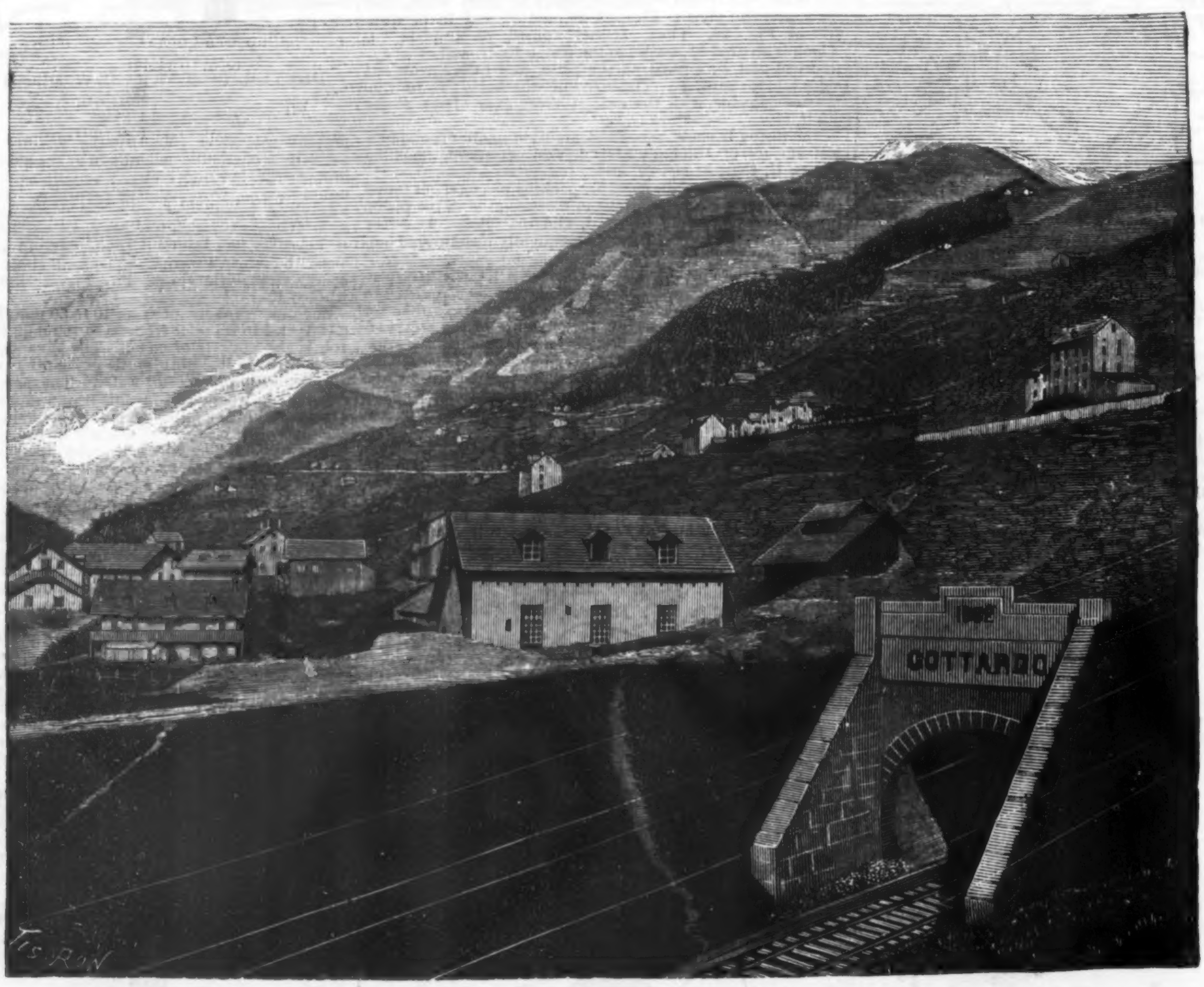
The total number of travelers in 1882 was 533,605. Each therefore traveled, on an average, 51·55 kilos (31·95 miles).

The figures of the report show that the movements of the travelers were to a great extent local, while the goods carried consisted principally of through freight.

The following are the figures for the seven months of 1883, ending Sept. 30:

Number of passengers carried.........	706,142
Freight in tons	308,659
Total receipts..............................	7,903,206·42 fr.
Total expenses of operating...........	3,835,998·37
Excess of receipts over expenditures...	4,067,728·05

—*Abstract from Le Genie Civil.*

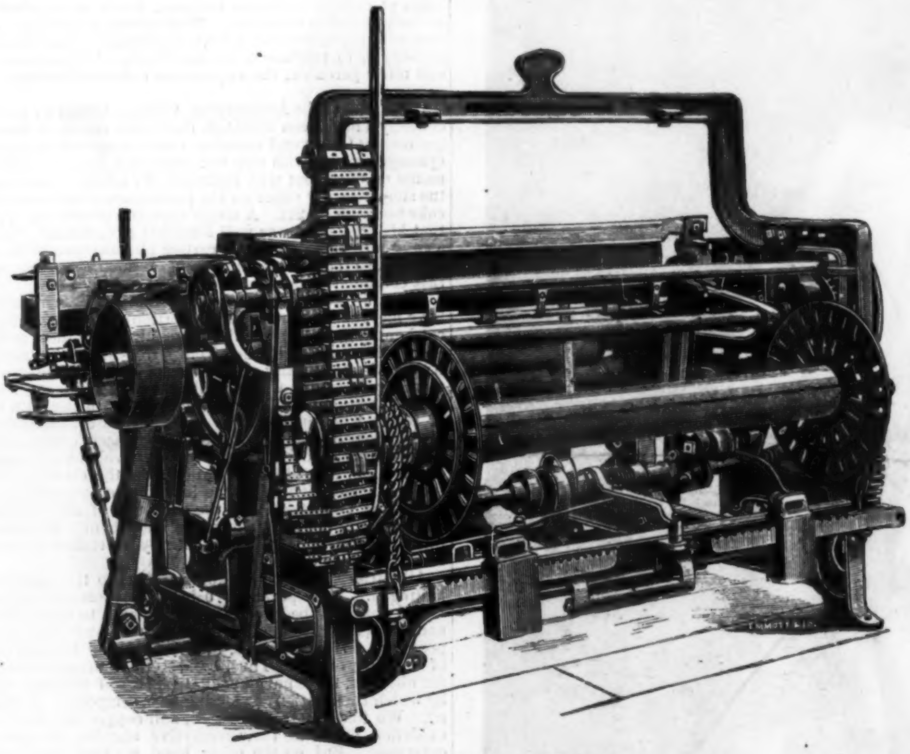


ST. GOTHARD RAILWAY.—AIROLO, ENTRANCE TO THE GREAT TUNNEL.

IMPROVED HANDKERCHIEF MOTION FOR LOOMS.

The loom is an ordinary plain calico loom, 40 in. wide—that is, it works with only one shuttle, and has the usual tappets for treading. Made by W. Dickinson & Sons, machinists, Blackburn. The novelty consists in the addition of a motion by which, with a single shuttle and these tappets, not only can plain cloth be woven for the middle of the handkerchief, but also a pattern to form the borders, the weaving going on continuously at the speed of a plain loom. This, of course, is no small thing to achieve, and the great advantage of its use for the production of ordinary cotton or linen handkerchiefs will be at once understood. Three methods of producing the pattern borders with warp and weft of similar color may be mentioned, and they may, of course, be used in combination. Thicker weft may be picked across at certain intervals, which, for continuous working, compels the use of a two-shuttle drop-box loom, which should be, though not of necessity, pick and pick. Some times with plain looms these picks of thicker weft are put in by hand, causing, therefore, a stoppage of the production. This plan can only be resorted to when the number of these picks in the border is very few, otherwise the delay in the weaving would be intolerable. The rib of thick weft may, however, be very conveniently simulated by putting two or more picks of the usual weft into the same shed. This also may be accomplished by hand, the loom being stopped and the shuttle passed back and fro through the shed the required number of times. As the taking-up motion remains stationary during this operation a thicker place is produced at this point, and the pick of thick weft is imitated. As before, the stoppage delays the weaving, and the plan cannot, without great inconvenience, be used for borders that require several ribs of thick weft to construct them. To keep the loom running a dobby is used, arranged to weave plain in the middle and to tread as required for the borders. The third method of obtaining with a single shuttle loom a difference in the weave is to put several picks of weft into the same shed while the taking up proceeds. A rib is not

now produced, but a stripe of a different weave to the rest of the cloth, but of the same thickness. This plan also requires the employment of the dobby. To run continuously, and therefore to avoid the loss of time taken up by such expedients as inserting picks by hand, has so far necessitated the use of either a drop-box motion or a dobby, the addition of either of which at once reduces the speed of the loom from 30 per cent. to 40 per cent., according to circumstances. By means of the arrangement under notice, however, the required result can be obtained without drop-boxes or dobby and without reducing the speed of the loom. The motion is a simple one, and will be easily understood. The tappets, which are of the usual form for plain weaving, are not secured to the tappet shaft, but are driven from it through the medium of a clutch, which, when disengaged, allows the shaft to continue revolving while the tappets remain stationary. Therefore, according to the length of time they are kept in this condition, any number of picks, even or odd, may be put into the same shed. The clutch is under the control of a set of lattice bars, clearly seen in the engraving, a peg in which causes the disengagement of the clutch and a succession of pegs for the tappets to remain out of action for the desired number of picks. There is a feature of this motion that deserves particular mention. The lattice is moved one bar for each revolution of the tappet shaft, and therefore represents two picks, or more correctly, perhaps, a bar covers the time of one pick, and the succeeding space or lattice the next pick. It must not be supposed, however, that the number of bars in the lattice is half the number of picks in the complete handkerchief. If such were the case, it would be very unwieldy indeed, and in order to get over this difficulty or inconvenience an ingenious expedient has been adopted. The taking-up roller, through the medium of a pair of change wheels, actuates a small disk containing on its face a pair of studs that may be set nearer to or further from each other, being adjustable in a circular slot. This disk makes one revolution during the weaving of a complete handkerchief, and to make the article longer or shorter the change wheels are selected to drive the disk slower or quicker. When the center part is being woven the catch that operates the lattice barrel is out of action, and the tappets are doing the usual plain tread. As, however, the weaving proceeds until the position for the border is reached, the disk, slowly turning, has at this point brought its first stud in contact with a lever, which action throws the catch of the lattice barrel into gear, and the treading will now be controlled according to the pattern. As the disk turns, the stud passes the catch-lever and allows it to drop, when plain weaving is proceeded with until the second stud again lifts the lever, and another border is produced. It will now be seen that the distance the studs are set apart governs the amount of plain cloth between the border of the handkerchief finished and the one just begun, and half of it is of course the margin round the pattern, and is itself an actual part of the border. Another point remains to be mentioned. The lattice bars, in addition to holes for the pegs that command the shedding, have also holes for another set of pegs used for controlling the taking-up motion. A peg inserted in one of this row of holes lifts the taking-up catch out of action, and a succession of pegs sustains it in this condition. This is timed to occur at the same time as the stoppage of the treading, and therefore a rib is produced when required. The motion is, without doubt, well adapted for its purpose, and we are informed that although introduced comparatively recently, about two thousand of them have already been supplied. The speed at which they run with efficiency is about 220 picks, which, taken in connection with the continuous running, is stated to increase the production by about 50 per cent.—*Textile Manufacturer.*



IMPROVED LOOM MOTION.

POTASSIUM AND ITS USES IN THE ARTS.

POTASSIUM is one of the alkaline metals. The following are the chief characters of this metal: It is of a bluish white color, and presents a strong metallic luster. At 32° it is brittle, and has a crystalline fracture; at a somewhat higher temperature it is malleable; at 60° it is soft and of the consistence of wax; at 130° it is completely liquid; and at a red heat it becomes converted into a beautiful green vapor. Its affinity for oxygen is so great that on exposure to the air it immediately becomes covered with a film of oxide. When heated, it burns with a violet flame. Its intense affinity for oxygen is well shown by throwing it into water, on which, from its low specific gravity (0·865), it floats. The metal abstracts oxygen from the water, and forms oxide of potassium; while the liberated hydrogen carries off a small portion of the volatilized potassium, and, taking fire from the heat evolved by the energetic chemical action, burns with a brilliant violet flame. The experiment is a very beautiful one, the burning metal swimming about rapidly on the water, and finally disappearing with an explosion of steam, when the globule of melted potash becomes sufficiently cool to come in contact with the water. At an elevated temperature, this metal removes oxygen from almost all bodies into the constitution of which that element enters; and in the laboratory it is often employed to remove any traces of oxygen from hydrocarbons, by distilling the latter with a small quantity of the metal. From the above facts it is obvious that potassium must always be kept in some fluid, such as purified rock oil or naphtha, which contains no oxygen.

Potassium does not occur in the native state, and can only be obtained by the reduction of its oxide, potash. There are three principal modes of reduction, all of which deserve a brief special notice, either on historical grounds or for their practical value.

1. Davy, in 1807, decomposed a fragment of hydrate of potash, by the current of a strong voltaic battery, into potassium, which separated as globules at the negative pole, and oxygen, which was evolved at the positive pole. This mode of procuring potassium yields only very small quantities, and is expensive; but the experiment was a most important one for the progress of chemistry, as showing for the first time that potash is not, as was previously supposed, a simple body.

2. Stimulated by Davy's discovery, Gay-Lussac and Thenard, in the following year (1808), succeeded in obtaining the metal by purely chemical means in great abundance by decomposing potash by means of metallic iron at a white heat. The oxygen of the potash combines with the iron, and the potassium in a gaseous form is condensed in a receiver filled with naphtha, and kept cool.

3. The method now usually adopted consists in the distillation of a mixture of carbonate of potash and charcoal at a white heat in an iron retort. If proper proportions are taken, the mixture is wholly converted into carbonic acid and potassium.

Potassium forms two compounds with oxygen, viz., a protoxide, which constitutes potash, and is strongly basic, and a peroxide, which does not combine with acids, and of which it is unnecessary to say more than that it is a yellowish brown substance which is found when the metal is burned in an excess of oxygen gas.

Potash can be procured in the anhydrous form by oxidizing thin slices of the metal in air perfectly free from moisture or carbonic acid. It is white, very deliquescent, and caustic. A far more important substance is the hydrate of potash or caustic potash. This is commonly prepared by dissolving carbonate of potash in ten times its weight of water and gradually adding to the boiling solution a quantity of slaked lime equal in weight to half the carbonate of potash used. One of the resulting compounds is hydrate of potash, which is afterward evaporated in alcohol to remove the impurities, when pure caustic potash is obtained. It is a powerful caustic, and quickly destroys both animal and vegetable tissues, and hence its solution can only be filtered through pounded glass or sand. Its affinities are so powerful that few vessels are capable of resisting its influence. Its solution must be preserved in glass bottles, into the composition of which no oxide of lead enters, as it has the property of dissolving this oxide out of the glass. Vessels containing silica (such as earthenware, porcelain, etc.) are decomposed, and platinum itself is oxidized when heated in contact with it.

Potash decomposes the fixed oils, and converts them into soluble soaps; when fused with silicious minerals, it displaces the bases and combines with the silica, forming silicate of potash. Potash is extensively employed in the arts; to the soap boiler and glass maker it is indispensable; when combined with nitric acid, it enters largely into the manufacture of gunpowder; and, in greater or less quantity, it furnishes important aids to a variety of manufacturing processes. In the laboratory potash is constantly used for absorbing acid gases, such as carbonic acid, and for separating the metallic oxides from solutions of their salts, since, owing to the powerful affinity of the alkali for acids, it readily decomposes the salts of all the metals which produce oxides insoluble in water.

We shall now briefly notice the most important of the salts of potash. Carbonate of potash is obtained by burning plants in dry pits, dissolving the ashes in water, evaporating till the sulphates, chlorides, etc., separate in crystals, and then boiling the mother liquid to dryness in iron pots. It is a compound of great importance both as a chemical reagent and as entering largely into the preparation of most of the other compounds of potash, and into the manufacture of soap and glass. Bicarbonate of potash is largely employed in medicine for making effervescing draughts. Sulphate of potash is also employed in medicine for the purpose of finely comminuting vegetable matters. The bisulphate is occasionally used as a flux. Chlorate of potash is employed in the manufacture of lucifer matches, in certain operations of calico printing, and for filling the friction tubes for firing cannon. The silicates of potash are important compounds in conection with the manufacture of glass; they also enter into the composition of water glass or soluble glass, and have been employed by Ransome and others as a coating by which the decay of magnesian and other limestones may be prevented.

There are a number of other salts of potash whose properties it would take too much space to discuss here, but the above mentioned are the most important ones as far as industrial uses are concerned.—*Glassware Reporter.*

CREFELD TECHNICAL SCHOOL.

TECHNICAL schools have usually been arranged with the idea of affording instruction in the theory of the various mechanical industries comprised within their scope, the practical illustration of these fundamental ideas being, for the most part, reserved for the period during which the students actually entered the various branches of industry, with a view to which their theoretical studies had been carried on. Thus at Crefeld such means as existed of illustrating the actual practice of weaving were upon a scale calculated to represent the domestic industry, rather than the working of the modern system of factory production. The more extensive adoption of the latter principle in France necessitated similar measures in Germany, and the progress made in this direction has already been referred to in these columns. With this modification of the general plan of working, a revision of the existing system of instruction became necessary in order that students might acquire their technical knowledge under circumstances more closely resembling those of their future business career. The manifest need of the facility of illustrating on the spot the theories propounded by the various instructors led to the adoption of a scheme which necessarily comprised the principal features of a large manufacturing business.

Although the school has been established in its present shape mainly through the instrumentality of leading members of the Crefeld silk trade, its objects are by no means restricted to that branch of manufacturing industry. As the director (Herr Lembcke) remarked at the opening ceremony, the institution will, in all its various branches, pay attention to all kinds of weaving, dyeing, and finishing, keeping in view the idea of so bringing together the most varied results of the art of weaving, that manufacturers may acquire the facility of rapidly and with certainty utilizing the effects of one material in connection with others, while refraining from being copyists in the ordinary acceptation of the term. The situation of Crefeld makes this programme quite appropriate, for the woolen manufacturing districts of Aix-la-Chapelle, Eupen, etc., are within a reasonable distance, while the important cotton industry of Gladbach is almost at its doors. There are in the immediate neighborhood many factories engaged in various branches of the linen trade (which was at one time the staple employment of that part of Germany), and the Westphalian linen manufacturing district is not far off, so that the founders of the school have every reason to expect that the various centers of textile industry will be adequately represented among the students, the carrying out of their intentions on the subject as referred to being thus rendered possible.

The history of the foundation of the institution (lately opened by Herr Von Gossler, the Prussian Minister of Education) evinces the hearty co-operation of all concerned. The Crefeld Chamber of Commerce had, in the year 1878, given much attention to the question of remodeling the existing weaving school, and on the matter being submitted to the Minister of Commerce then in office (Dr. Achenbach), arrangements were made for sending an organized deputation to France, with a view of studying the operation of the technical educational institutions already existing in that country. This traveling commission included Herr Emil de Greiff, leading manufacturer, and Herr Heimendahl, President of the Chamber of Commerce. The invaluable and constant services of these two gentlemen, since that time, met with appropriate recognition at the inaugural festivities, and the success of the work now completed is attributed, in a great measure, to the practical knowledge of the requirements of the institution which are thus at the disposal of its founders.

The municipality of Crefeld gave the site (over an acre in extent), and contributed £7,500 to the work. According to a recent statement of the *Cologne Gazette*, the Prussian Landtag voted the amount of the cost of the building, which was upward of £25,000. In addition to the necessary offices, class-rooms, lecture-rooms, etc., there is a shed building with an iron roof, containing eighty hand-looms and a number of power-looms. Electric light is used for illuminating purposes. Two large boilers supply the steam used as motive force. It is in contemplation to extend the present scope of instruction by fitting up a special department with the necessary machinery for testing the application of motive power to hand-looms, and thus allowing the domestic industry to share in the general manufacturing progress of the district. Among the incidents connected with the foundation of the school is the action of the inhabitants of Crefeld, in establishing scholarships for young men wanting the pecuniary resources necessary for prosecuting their studies; this having been the form in which the golden wedding of the Emperor of Germany was commemorated at Crefeld. The maintenance of the school is provided for in the following manner: One-half by the State, one-quarter by the municipality of Crefeld, and one-quarter by the Local Chamber of Commerce. The latter body has engaged to contribute a yearly amount of £750 from the proceeds of the silk condition house.

A notable addition to the educational resources of the school is afforded by the Krauth collection of tissues, em-

broidery, needlework, laces, trimming, wall-paper, etc., which was acquired by the State and presented to the school. The original school only had 21 students, while the new establishment has 140 in the weaving branch, and 30 in that devoted to dyeing and finishing.

The following summary indicates the principal features of the course of study at the new school: 1. The instruction of foremen, designers, and manufacturers for all branches of the weaving industry, and for mechanical engineering in connection with it. 2. The instruction of students who wish to learn chemistry, by as thorough a training as possible in all branches of this science, and in its practical application. 3. The instruction of those students who wish to follow the dyeing, bleaching, printing, and finishing trades, in the manufacture of dyes and mordants, and in the methods of testing and valuing natural and artificial dyestuffs and chemicals. 4. The carrying out of practical operations in dyeing, bleaching, printing, and finishing in such a manner as to facilitate students carrying into practical effect the theoretical instruction they have received.

Herr Lembcke, the director of the school, had previously occupied an important position of a similar nature at Chemnitz. The head of the finishing and dyeing branch is Dr. Lange, from Stuttgart.

THE BOAR HUNTER.—BY OTTO LANG.

THE BOAR HUNTER.

OUR engraving, from the *Illustrirte Zeitung*, represents Otto Lang's statue of the Boar Hunter. The man stands with one foot resting on his booty, and in his right hand he holds the spear with which he has killed the animal, while in his left hand he holds the horn with which he has signaled his victory. It is a spirited and striking work.

Land and Water says that Lord Tennyson has written a $750 poem on blackbirds, and blackbirds are only quoted at 7 cents apiece. This shows how much raw material it takes to make a poem.

THE PRODUCTION OF AMMONIA BY THE ACTION OF FREE HYDROGEN ON NITROGENOUS COMPOUNDS.

By R. TERVET.

PRELIMINARY to a more extended treatment of this subject, I beg to contribute to the *Journal* the subjoined brief notice thereon.

In following up the experiments previously detailed, upon the production of ammonia by passing hydrogen over coke resulting from the destructive distillation of coal,* I find that the reaction is one common to nearly all nitrogenous bodies, and that the majority of compounds yield up their total nitrogen in the form of ammonia so easily and so completely, that it may be adopted as an analytical method for the estimation of nitrogen.

The compounds experimented upon were the following: Ferrocyanide of potassium, ferricyanide of potassium, cyanide, sulphocyanide, cyanogen, paracyanogen, nitrate of soda, nitrate of potash, nitrate of ammonia, nitrous oxide, nitric oxide, nitric peroxide, nitrate of urea, urea, quinine, tobacco,† melon, nitroprusside of soda, nitrobenzol, dinitrobenzol, nitronaphthalene, pyrrol, alkaloids from crude shale oil, boron nitride.

In choosing such widely different bodies for experiment, an effort was made to ascertain experimentally the exact conditions under which the nitrogen acquires the property of combining with free hydrogen; but in the course of the investigation the more intimate study of the phenomena impressed me with the conviction that this is another of those unique characteristics which enable nitrogen to hold so distinct a position among the elements. Indeed, with the exception of carbon, there is no element which gives rise to so endless a variety of compounds as nitrogen. Many of these compounds contain only a very limited number of the different elements in their composition, and yet may contain as much as 20 atoms of nitrogen. Nitrogen compounds also exhibit the most wonderful changes under the phenomena of polymerism, metamerism, and isomerism. Again, the affinity of nitrogen is so weak as to be incapable of application; but when in combination, in the form of cyanogen, paracyanogen, potassic cyanide, titanic nitride, etc., it may withstand the temperature of a blast furnace without decomposition; while these very same compounds, if subjected to a moderate temperature in an atmosphere of hydrogen, are immediately decomposed, with the production of ammonia.

In order not to be misled in such experiments, it was necessary to avoid the employment of salts containing water, or such as might give rise to the formation of water by the hydrogen. The presence of water would undoubtedly propagate reactions which would make them no longer fit for such an investigation. My earlier experiments were confined to the cyanides and ferrocyanides. The examination of the substances mentioned above does not call for any special remark, with the exception of the last three.

Experiments with the solid substances were, as far as possible, conducted on one uniform method. A quantity of the salt is taken and reduced to the finest state of subdivision. A portion (dependent upon the percentage of nitrogen which it may contain) is then weighed off, and is incorporated with a given weight of finely elutriated pumice-stone. The mixture being placed in a metallic boat, the latter is then pushed into a malleable iron tube, heated to redness, and through which a current of hydrogen is passing. The ammonia is produced at once, and admits of easy collection and estimation. The last traces are, however, somewhat slow incoming off.

Pyrrol and alkaloids do not seem to be so susceptible of decomposition as the other substances. Perhaps this arises from the fact that they are already *ammonias*, and, as such, conform, within certain limits, to the conditions under which ammonia is produced. For the oxides of nitrogen and cyanogen, a special adaptation is required to conduct the gas into the combustion-tube. With the nitrogen oxides the reaction takes place with explosive violence, which varies according to their degree of oxidation. With nitrous oxides, and when carefully regulated, the minute explosions occur with such rapidity as to produce a musical sound. With nitrous acid and nitric peroxide, the experiment becomes decidedly dangerous.

Dr. Mills, of the Andersonian College, Glasgow, to whose courtesy I have been indebted, during the course of these experiments, for several valuable hints, suggested to me paracyanogen mixed with clay as a substance likely to yield ammonia on treatment with hydrogen, by means of the apparatus shown in my paper on the production of ammonia from coke (see *ante*, p. 21). A single experiment sufficed to prove that his prediction was well founded; and, further, that it is a substance containing only carbon and nitrogen in its composition, so that the production of ammonia at once shows that combination does take place.

Boron nitride is the most stable compound with which I have met; only a very small proportion of the total nitrogen can be obtained under conditions identical with those in which the whole could be obtained from ferrocyanide of potassium. An additional quantity of its nitrogen can be obtained as ammonia by fusing it with metallic sodium in an atmosphere of hydrogen; and a still larger quantity by fusing with oxide of lead. The total can be eliminated by oxidizing with caustic potash in an atmosphere of hydrogen. The cause of the difficulty of decomposing boron nitride hardly requires explanation, as it differs so much from the other nitrides—such as carbon nitride, magnesium nitride, iron nitride, copper nitride, etc.—that, with the exception of composition, it does not admit of any comparison with them. It, however, illustrates a physical property entirely dependent on the nature of the element boron.

All nitrides do not act alike in respect to the influence of hydrogen. Their power of being decomposed by hydrogen would appear to be directly proportionate to their affinity, and, consequently, the temperature to which they are exposed; or, in other words, in direct relation to their power of forming oxides. Thus, besides their unequal affinities for nitrogen, they have unequal powers of forming oxides, by which their action in yielding to decompositon is regulated. We find that carbon, iron, and copper admit of easy oxidation, and that their respective nitrides are easily decomposed. But, on the other hand, we find that boron is difficult to oxidize, requiring to be raised to an exceedingly high temperature, in an atmosphere of oxygen; and likewise that the nitride is difficult to decompose.

I have already pointed out that the chemical nature and the mechanical character of the mineral matter (such as ash) associated with nitrogenous bodies exert a great influence upon the production of ammonia. I find that in mixing some of the substances mentioned above with a very large excess of the finely elutriated pumice, the rapidity of evolution is greatly retarded; and with some of them diminished in quantity. This can be accounted for by the amount of contact surface being greatly diminished, and hampered by the presence of so much inert substance. It therefore follows that, exclusive of all other effects, longer time will be required for the liberation of the ammonia. This may, in some measure, account for the difficulty of liberating the nitrogen from shales by hydrogen, as compared with steam. Shales, as a rule, contain a very large proportion of ash, so that the steam, on burning away the carbon, makes pores and inroad passages through the body of the ash; thus exposing new surfaces to the action of the hydrogen. The penetration of the hydrogen into the pores of the ash is due to diffusion, and the expulsion of the ammonia may be the result of diffusion. The condition, therefore, most favorable for the production and preservation of the ammonia, when formed, is when the respective molecules have ample space to glide over one another, so that the ammonia may be brought as little as possible into contact with the surface of the ash by being surrounded with hydrogen, which prevents decomposition.

Silvestri* has pointed out that ammonia, on being made to pass through ignited lava, is decomposed into its elements; the whole of the nitrogen being absorbed by the lava. We thus see that these inert bodies play a far more important part than we are likely to ascribe to them; and that, besides their physical properties, they possess certain chemical properties by which they are enabled to produce decomposition, and even recombination.

The results of these experiments, in so far as they permit conclusions to be drawn as to the cause of the formation of ammonia, agree in all respects with the observations made on coal.—*Journal of Gas Lighting.*

* See *Journal* for January 1, p. 30.

† I consider it of sufficient importance to state here that quinine and tobacco do not yield all their nitrogen as ammonia; the greater portion being liberated as bases.

* *Gazetta Chimica Italiana*, anno v, (1879), fasc. vi.

DR. GUSTAV JAEGER.

PROF. GUSTAV JAEGER'S name is quite well known in the scientific world, and he has made it very popular as superintendent of the Zoological Gardens in Vienna, and by his numerous scientific publications. He is the son of a clergyman, and was born in Boerg, in Würtemberg, May 23, 1835. He studied in Tübingen and Vienna, in which latter place he was tutor of natural science at the university. Since 1866 he has resided in Stuttgart, where he is Professor of Anthropology, and publishes works on zoology, his work on "Biped Zoology" being worthy of special notice. He began his experiments on his own person, as he noticed the evil effects of his sedentary habits and his increase in corpulence. By chance and much mental labor he discovered the advantages of sheep's wool for clothing, and the beginning being found, all the rest followed in its natural, logical course. On his own person and those of the members of his family he made experiments with his new system of clothing. He was ridiculed from all quarters, but that did not prevent his proceeding with his researches, and he has so far succeeded that the question of wearing woolen clothing only has become a public one. But Prof. Jaeger was not satisfied with having described the wool clothing only; he also published a physiologico-psychological work on the advantages of woolen clothing, which work he has named "The Discovery of the Soul;" but it really has no connection with the "normal clothing," as he names it Jaeger's handbooks on the "normal clothing," are sold in most book stores in Germany, or they can be obtained from the branches of the factories making the "normal wool clothing." Ten factories in Wurtemberg are now fully employed in making the "normal wool" fabric.

Prof. Jaeger has lectured in Germany, and on January 5, 1884, delivered his first lecture in Vienna, which was one of the best that has been delivered in that city for years. He stated that it was not his object to cure sickness, but to prevent the same. He also said that he was well aware that his woolen clothing would not prevent incurable diseases, but that it would make mankind hardy and able to resist disease; that it would not only preserve health, but improve the physical and mental condition throughout; all exhalations from the body would be absorbed, and the health would increase, as a decrease in the quantity of fluids in the body corresponds to an increase in health, and an increase of the fluids corresponds to a decrease in health; the flesh would be hardened and the accumulation of fat would be avoided, the muscles toughened, the mind eased, etc. All that was stated by Prof. Jaeger in his lecture is given in "Prof. Jaeger's Monatsblatt," published by Kohlhammer, in Stuttgart. Hundreds of thousands in Germany wear his "normal clothing."

DR. GUSTAV JAEGER.

Prof. Jaeger's theory is in brief as follows:

Everything that is worn by mankind should be made from sheep's wool, which must be white or dyed with harmless chemical colors, no aniline colors being used. Experience has shown that knit woolen fabric is the best. Over this underclothing plain upper clothing is worn, no overcoats, no great coats, cloaks, etc. The breast must be well protected, and for this reason the front of the garments covering the breast is made of a double layer of fabric for ladies as well as gentlemen, thus giving the garment the appearance of the double-breasted military coat. This is the only point in which the style of Prof. Jaeger's clothing differs from the clothing worn at the present day. Hats and caps must be made of wool, and beds and dwellings must be changed accordingly. The beds must be made of sheep's wool, the floors of dwellings must be oiled, and the furniture oiled or varnished. Much of Prof. Jaeger's theory may appear absurd, but, nevertheless, he has had great success, and the probability is that he will have much more.—*Prof. P., in Neue Illustrirte Zeitung.*

We may add that abstracts of some of Prof. Jaeger's papers on wool clothing will be found in SCIENTIFIC AMERICAN SUPPLEMENTS, 253, 256.

CLOTHING IN ITS RELATION TO HEALTH.

THE ideas and scientific views of Prof. Dr. Gustav Jaeger of Stuttgart, regarding the properties of animal wool, gain more and more in popularity with German scientists, and in one of the latest numbers of the *Homœopatische Monatsblatter* (Homeopathic Monthly), which appears in Stuttgart, Dr. E. Schlegel, a well known physician of Tübingen, has published an essay, in which he speaks of Professor Jaeger's theories as follows:

Among the discoveries that have been made during the last few years in medical science, some facts brought to light by Dr. Gustav Jaeger regarding the amount of water contained in the human body may prove to be of the utmost importance. In this paper concerning "The resistibility of the human body against epidemic diseases and the power of constitution,"* Professor Jaeger has proved that the specific gravity of several individuals is very different, and that the state of the health of those individuals is closely connected with their specific gravity. The greater the weight of the human body in comparison to the space which it occupies, *i. e.*, the greater its specific gravity, the more it is able to resist epidemic diseases. Persons of a low specific gravity are taken ill from very insignificant causes, such as a cold, and are very susceptible to contagious diseases. Such persons have usually a certain fullness of body, and are even corpulent, but just that which gives them a great size is useless ballast, namely, fat and water. These substances endow the heaviest bodies with a comparatively low specific gravity, giving at the same time to the constitution little power of resistance.

Very different is the case with bodies of high specific gravity. Here neither fat nor water is superabundant, the flesh feels solid, and the bodily constitution possesses a high power of resistance. Professor Jaeger has investigated these differences of constitutional resistibility by comparing the specific gravity of a number of persons with their state of health. An accumulation of water in the tissues of the body he calls "Hydrostasis chronica," an expression which, as the whole discovery itself, reminds us of the teachings of the homeopathist Von Grauvogel respecting hydrogenoid constitutions, while the theory that a chronic accumulation of water in the body is the cause of many sicknesses is in perfect accord with the "Sykosis" described by Hahnemann, and afterward by Wolf.

The investigations and measurements of Jaeger are of an entirely new date, and we would not mention them here had not this discovery proved to be of the highest value for hygiene, and had not the conclusions of Professor Jaeger already been corroborated in a most remarkable manner.

If it is true, namely, that the specific gravity of the body is the measure of its resistibility of disease, and if it is also true that few bodies have this resistibility, because of an overabundance of fat and water, then the question arises, Have we any means of counterbalancing this superabundance, and therewith heightening the specific gravity? The homeopathists know a number of remedies for so-called hydrogenoid constitution, the most important of which is "Thuja." These remedies have to be chosen according to the individual constitution, and have proved to be of more or less benefit, sometimes even effecting a perfect cure. Allopathists use also several medicaments which are useful in cases of "Sykosis," but none of these remedies are entirely satisfactory.

Professor Jaeger has now, by his careful investigation, discovered a simple and natural expedient for preventing the accumulation of fat and water in the system, which is suitable alike for rich and poor. It consists in adopting a new sort of clothing, we might call it a normal clothing.

The Professor has tested the value of his discovery upon his own person and members of his family, and so has the writer of these lines, who, after having the honor of making the acquaintance of Professor Jaeger in 1879, adopted, at his suggestion, the normal clothing, and recommended it to some thirty or forty persons since. The experiments made by wearing the clothing in the heat of summer and the cold of winter have proved highly satisfactory.

The normal clothing has two essential properties:

1. It consists exclusively of wool, avoiding all materials woven from plant fiber (cotton or linen).

2. It makes a strong point of keeping warm the middle line of the front of the body.

The principle peculiarity of Professor Jaeger's clothing is the exclusive use of sheep's wool, even avoiding pocket and other linings of cotton.

To every thoughtful person it will be a source of satisfaction to know that Professor Jaeger has chosen for the warming of the body only those means which nature has given for the same purpose to those mammals which are the most nearly related to man. The fittest and the most suitable always predominates in nature, and if in this case we inquire why hair and wool clothing are the best protection against cold, the answer will be found in the physical properties of these matters. A cover of wool is far more porous than that of plant fiber. The latter, if exposed to moisture, becomes thoroughly soaked with the liquid and sticks to the body, so that no air remains between, and only one smooth evaporating surface is formed, whereas a hair of wool cover, being never entirely soaked, does not cling closely to the body, but forms a surface which is broken by air bubbles, permitting a great quantity of moisture to pierce to the outside, where it can evaporate. Moisture from the outside is prevented from piercing through the cover to the body on account of the layer of air between the cover and the body, which offers a kind of resistance.

These properties of hair and wool clothing are very important, for the skin of each animal is a source of evaporation, and continually renders moisture to the air.

That difference which exists between plant fiber and wool in regard to the conductibility of heat renders the superiority of wool clothing in regard to health still more evident. Wool is a bad conductor of heat, therefore wool clothing conserves the heat produced by the body, while cotton, and still more linen, permits this heat to quickly escape and eradiate. This fact accounts for the cool, chilly feeling produced in putting on linen clothing, while in putting on woolen no loss of heat is felt.

The conservation of the heat of body produced by woolen clothing has the consequence that the skin remains in a blood-rich state, and may perspire more freely than when exposed to a quick refrigeration by cotton or linen clothing.

To these important properties of wool, which are sufficient proof of its suitability for clothing, a new one has been added by Professor Jaeger's latest investigations, which we will only mention briefly, as an explicit description would occupy too much space.

Jaeger has proved that in our organism there are certain gaseous volatile substances, called by him "Duftstoffe" (odorous substances), which play a very important part, as yet undivined. He endeavors to show that the actions of our mind are mediated by these substances, and that they are continually rendered free in the acts of breathing and perspiring. He discerns two different groups of odorous substances—"Lust and Unlust Stoffe" (substances of pleasure and disliking). The first ones are exhaled during a joyful and agreeable state of mind, and produce this state of mind if inhaled. Just the reverse is true of the second ones. Whoever will take the pains can discover for himself that the evaporation differs according to the condition of the mind as well as the condition of the body. During joy and happiness the odor of perspiration is not disagreeable, while during anguish and great nervous excitement it is offensive. The substances of disliking have, therefore, a bad odor. In an atmosphere of these substances the vitality is lowered and disadvantageously influenced. This accounts for the fact that in a state of anguish and fear the body is more susceptible to contagious diseases. The inhaling of the "substances of pleasure" heightens the vital actions and improves the resistibility of the body against sickness. Jaeger has now discovered that "sheep's wool" attracts the "substances of pleasure" [this property must not be confused with the great capacity of wool for absorbing odors in general], while clothing made of plant fiber favors the accumulation of the offensive "substances of dislike," with all their evil consequences.

Even with healthy persons, cotton and linen clothing, after long wearing, takes a distinctively repulsive odor, while woolen clothing, even in summer, when evaporation is strong, takes only the sour smell of perspiration, and never accumulates other offensive smells. This seemingly unimportant fact, the mention of which may be ridiculed by many, is, nevertheless, of the greatest value to medical science, and has proved of the highest importance for the "resistibility of the human body against contagious diseases."

Thus far Dr. E. Schlegel. The full responsibility of this report of the hypothesis of odorous substances we have to leave to the editor of the "Homeopathic Monthly," in Stuttgart, and its learned contributor, but we believe that the facts are very interesting and of great value, as they are based upon exact scientific investigation. Especially deserve to be mentioned the several thousand experiments regarding odorous substances which have been made with the "chronoscope," an instrument by which the celerity of nervous conduction is recorded.

* "Seuchenschutz und Constitutionskraft."

DIPHTHERIA.

THIS is a disease of the human body arising from the inhalation of germs floating in the atmosphere, which coming in contact with the mucous membrane of the air passages, and meeting with a soil capable of germinating them, take root, develop their organism, complete their function by the perfection of new germs, and die. And happy is the physical organization that endures the shock and the exertion of raising a crop of these parasites

On this view of the matter medication should be directed more to the relief of the symptoms than the destruction of the causes, at least so far as the patient is concerned. Sanitary measures of course are essential for preventing the spread of the infection.

The essential point in our proposition rests upon the statement that the germs, coming in contact with a soil adapted to their nature, take root and grow. This is the infectious quality of the disease, and forcibly brings to mind the fact that it very often happens that the disease affects but one of a family, while several escape, showing very conclusively that the physical condition of the person has much to do with the acquisition of the disease, as well as the violence of its invasion.

The parasitic nature of the disease is also evident in the fact that it appears in patches that are somewhat elevated, of an ashen color, scattered over the surface of the tongue, fauces, tonsils, etc. These may also form in the lungs and along the intestinal passages.

When they appear exclusively on the tongue, but very little fever or other constitutional disturbance follows; as the tonsils and air passages are involved the febrile disturbance is increased, so that the tongue becomes extensively and deeply coated with the elongated fur incident to fever in general. In such cases the ash colored patches covered by the parasitic growth still maintain their appearance, though not so prominent, and even occasionally they are less elevated than the surrounding febrile coating.

When the tonsils are involved, they become swollen, sometimes to such an extent as to embarrass respiration. When the lungs are extensively involved, there is the difficulty of breaking from impeded respiration, and danger in proportion to the interference with aeration. If the carbon from exhausted or dead tissue cannot be thrown off by the lungs, anæsthesia of the brain follows, and the patient dies comatose, without the appearance of much suffering.

When the disease locates itself upon the mucous membrane of the stomach, there is a more extensive production of fever, arising from the debility of impaired digestion and the poisoned condition of the blood, that has been deprived of some of its essential qualities by the parasites that have abstracted the materials of their growth from it. In this condition the excreta are in some degree putrescent, and give the exhalations from the lungs a very offensive odor—this by some is regarded as diagnostic of the disease. When the parasitic growth is extensively developed upon the bowels, there is at first no secretion and ultimately a discharge of putrescent material, consisting mainly of decomposing ingesta with some of the fluid secretions of the bowels. These forms are exceedingly dangerous in their tendencies, not only during their progress, but in the convalescence, as the exfoliation of the diphtheritic patches may open some blood-vessel of sufficient magnitude to produce a hemorrhage.

Occasionally the liver will become affected by the absorption of the germs into the blood, which passing through the liver, that happens to be in a condition to develop these germs, they take root and grow, but having no sufficient mode of egress as they exfoliate, become a foreign body to its structure, hence become exceedingly dangerous to the patient. The evidence of this complication is manifest in the impaired quality of the biliary products, by which the skin is browned to a slight extent; and when the swelling has increased so as to press upon the bile ducts, jaundice occurs from the absorption of the bile by the blood through the walls of the vessels of the liver.

This brief review of the signs of the disease includes the principal phenomena apparent in the development and progress of the disease. Of course, in this as in all other forms of prostrating disease, the nerve power is weakened; the heart and arteries acting with less energy do not clasp or grip the blood so closely, hence a larger current is continually passing in the arteries, manifested by fullness of the pulse. The same weakened energy permits the blood to remain longer in the small vessels or capillaries, giving the heat of the skin, marking fever, while the same loss of power disables the glands of the skin as well as of other parts of the body from exercising their functions, hence there is no secretion, and the skin is dry, the bowels inactive, etc. There being no relief from this condition, there comes, sometime in the course of several days, varying from three to twenty, a decomposition of some of the elements of the blood, in which some of its particles become irritant, and exciting the nerve filaments lining the walls of the blood vessels through which they pass, cause them to contract more forcibly, diminishing the volume of the pulse, increasing the number of its beats, and driving the blood from the small vessels, contracts and pales the skin. In such cases the danger is imminent, and few recover. In the transition from the fever to the condition just described the patient will seem for a short time to be much better, but it is only a deluding phantom that leads to the gates of despair.

And now the important question arises, What shall be done to avert these serious results that threaten the life of the patient?

The proposition being accepted that the disease exists by reason of the condition if the body being such as readily develops the germs of diphtheria, it is clear that the treatment should be directed to the restoration of the healthy condition of the body, and leaving the disease germs to die out for want of adequate nourishment.

It is a very tenable proposition that a healthy condition of body is invulnerable to the force of disease; and were the profession to give more stress to the restoration of healthy conditions than to the cure of diseased ones, patients would have occasion for rejoicing. Now, in the case under consideration, the parasite finds a foothold in a somewhat swollen and spongy mucous membrane that contains more than the ordinary quantity of mucous elements in its organization, which are unhealthy in degree proportionate to the excess. The irritating presence of the parasite intensifies the action of the part on which it is located, hence there is increase of bulk, with compression upon the circulating vessels, or in the language of the profession, congestion with formation of false membrane.

Passing by the technical expressions that only mislead, a knowledge of the action of remedies informs us that belladonna will relax the tonicity of tissues, and that in case of swollen tonsils or mucous glands, and permit the swelling from impacted capillaries to be relieved.

It also, from its paralyzing power upon the nerves of organic life, is a check upon organization; its use therefore will cover two points of suffering, and contribute that far toward the patient's relief again. Ipecacuanha is one of the most valuable agents for promoting exfoliation of the mucous membrane, and is invaluable in this disease. So that in the uncomplicated forms of this disease these two remedies meet all the indications of the case, and experience has demonstrated them to be the most valuable of all the remedies yet suggested or proposed.

In the administration of remedies, it is always desirable to have them as palatable as possible, and these readily are made so as to be unobjectionable even to children.

The most acceptable form of administration that has occurred to the writer is to take of atropia one grain, ipecacuanha two drachms, pulverized sugar four ounces; triturate them thoroughly together, and to an adult may be given from five to ten grains of the compound every quarter or half hour until the dryness of the throat and flush of the skin peculiar to the action of belladonna are apparent, this condition should be maintained in slight degree while the disease lasts.

The dose for children, however, is proportioned to their age, and where there is difficulty in swallowing, the remedy may be dropped on the tongue, where it will be absorbed by the fluids of the mouth.

While under treatment, the patient is not necessarily confined to bed, unless too weak to be up. The room should be well ventilated at least an hour once or twice a day. If convenient, the patient should be removed to another room (properly warmed), while the sick room is ventilated by having the doors and windows all thrown open for an hour or so.

The bed and body clothing should all be aired, or what is better, changed once a day; where such conveniences as two rooms are not readily available, let the patient be well covered up in fresh bed and body clothing with enough overclothing to keep the body perfectly warm, and have the doors and windows open even in coldest of weather until the atmosphere of the room is completely renovated. As a disinfectant there is nothing better than burning a few sulphur matches in the room after the ventilation has been completed, and impregnating the atmosphere with the sulphurous odor until its presence is barely perceptible.

Under this line of treatment the writer in a living practice of thirty years has not been so unfortunate as to lose a case; nor are his patients ever seriously troubled with the throat affections—gargles and caustic applications to the tonsils are not called for, and much of the barbarism of treatment is avoided.

While speaking so positively upon the merits of this mode of treatment and the success attending it, the writer is not unmindful of the dangers attending the location of this disease upon the lungs or other glandular organs of the body. In the treatment of these, the peculiar conditions must receive attention in conjunction with the treatment already related. Such complications, however, are not very numerous, and the writer recollects of no fatal results except in complications involving the liver. These are almost invariably fatal.

Whoever prescribes belladonna in any of its forms should never forget that its long continued use will, especially with corpulent or phlegmatic persons, relax the tension of the blood vessels so much that the capillaries of the kidneys will permit the serous elements of the blood to ooze through their walls unchanged so much as to present the appearance of albuminura.

A patient having been under this remedy should never be discharged from care by the physician until this matter has been looked into and corrected, which may be usually done by a few doses of ergot.

E. D. BUCKMAN, M.D.

Philadelphia, Pa., 1884.

SILVANUS THOMPSON'S TELEPHONIC APPARATUS.

PROFESSOR SILVANUS THOMPSON has recently patented some new forms of telephonic apparatus which are described as being modifications in, and additions to, telephones of

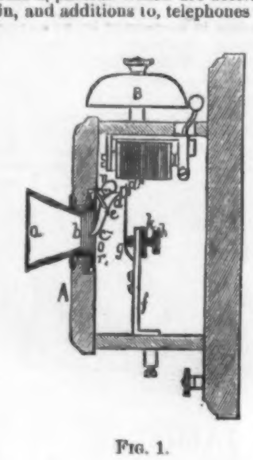


FIG. 1.

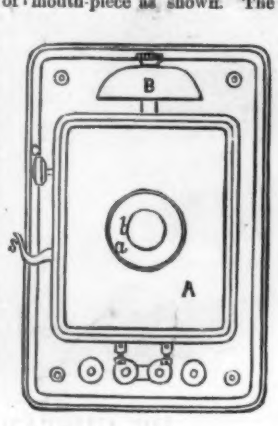


FIG. 2

the kind invented by Philipp Reis, and described in the years 1862 and 1863, in the journal of the Austro-German *Telegraph Union* and in Dingler's *Polytech. Journal;* and also in 1866 in Kuhn's "Handbook of Applied Electricity."

The inventor states that, by various details of construction and arrangement, he converts instruments which are practically useless for the present applications of telephony into highly useful and serviceable apparatus.

In the original apparatus of Reis, the person using the

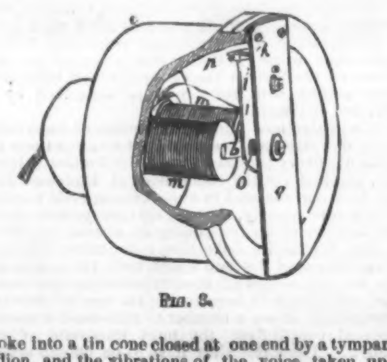


FIG. 3.

same spoke into a tin cone closed at one end by a tympanum of collodion, and the vibrations of the voice, taken up by the tympanum, were caused to act upon a small curved lever of which the material was not prescribed; it must, says Prof. Thompson, have been a substance that will conduct electricity, but it was to be as light as possible, and the plain inference from the description given is that it should be non-metallic. This lever rested with one end against the tympanum, and at the other end was caused by means of a delicate spring to press against a contact piece mounted upon a vertical spring, and adjusted to the requisite degree of contact by a screw. The function of this lever was to open or close the circuit to a greater or less degree, according to the vibrations imparted to it, and, by thus varying the contact between the parts, to throw the current into corre-

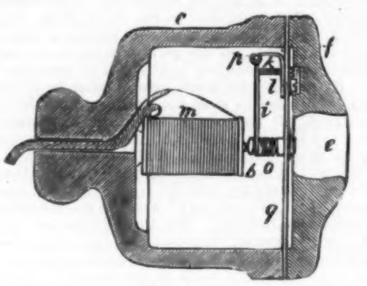


FIG. 4.

sponding vibrations; the object being to magnetize and demagnetize an electromagnet at the receiving end of the line, so as to make it increase and decrease in the force with which it attracted its armature which was consequently thrown into vibrations corresponding to the original vibrations. The aforesaid lever was made with its arms of unequal length, thereby sacrificing the range of its motion in order to obtain a greater range of force or pressure between the contact parts. The whole instrument was mounted on a stand.

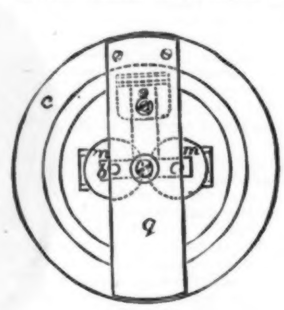


FIG. 5

Prof. Thompson's improvements in the transmitters referred to are illustrated by Figs. 1 and 2.

The box, A, can be fixed to a wall, leaving only the mouth-piece exposed; this mouth-piece is a hollow metal cone, *a*, *b*, so arranged that it may be screwed to the box from the outside. The frame or ring, *r*, which holds the tympanum, *o*, is affixed by screws or clamps to the socket which holds the mouth-piece as shown. The inventor finds that among tympanums of collodion variously prepared those which are made of the preparation of collodion known as celluloid are the most satisfactory, and are least liable to become flaccid with the moisture of the breath.

For making the curved lever, *c*, *d*, in order that it may be as light as possible, the inventor generally uses either aluminum or artificial *coke-carbon*, these substances being the lightest of good conductors available for the purpose. The artificial *coke-carbon* is however preferred. The action of

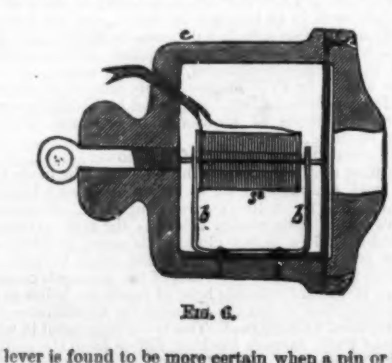


FIG. 6.

this lever is found to be more certain when a pin or pivot is inserted at *e*, to attach it to the support, *s*, which is preferably formed to receive the lever.

For the contact piece touching the lever at *d*, the inventor employs a small stud, d^*, of silver, nickel, native amalgam ore, or other good conductor of electricity, or, in some cases, one of the good conducting kinds of carbon, such as

pure dense graphite; the stud, d^*, is mounted on a slender vertical spring, g. The spring, g, is carried upon a metallic support, f, and its pressure against the lever, c, d, is regulated by an adjusting screw, h, provided with a locking nut, k.

Figs. 3, 4, and 5 show one form or modification of Prof. Thompson's receiver.

The original apparatus of Reis consisted of an electromagnet laid flat upon a sounding board or sounding box, and having in front of its poles an armature consisting of an iron bar of oval section attached to the end of a thin flat or plank-like lever, hung in the manner of a pendulum from a pivot or hinge, but restrained by a spring and an adjusting screw from swinging freely like a pendulum. According to Prof. Thompson's invention, this arrangement is modified for the purpose of getting a better acoustic effect, and a very convenient form of instrument, as follows, viz.: In order that the vibrating, plank-formed lever may affect the ear more satisfactorily, the whole of the parts are made smaller and more compact than in the original instrument of Reis, so that the instrument can be put directly to the ear, the whole being inclosed within a case, c, suitable to be held in the hand. This case, c, is a circular box of wood or other material closed at one end, open at the other, and provided at its wide end with a cover to serve as an ear piece or embouchure.

In the form shown in Figs. 3, 4, and 5, an electromagnet, m, is placed with its poles pointing toward the mouth of the case. In front of these poles, but not touching them, the armature, b (which is a bar or tube of iron of oval section), is fixed on or near one end of the thin broad lever, i, which should be made either of wood or of brass or zinc. This lever is pivoted at p to a support, k, like a pendulum. The motion of the lever, i, is controlled by the spiral spring, o, and the adjusting screw, l. The latter passes through the support, k, and the cross-bar, q, which may be of wood, brass, zinc, slate, or mica, and is screwed to the case at one of its ends. Another screw passing through the cross-bar, q, is screwed into the end of spiral spring, o. On the end of the box or case containing the parts above enumerated there is screwed a cover, f, of wood or other suitable material perforated with an aperture, e, as shown in Fig. 4. This aperture serves as an embouchure for the sounds emitted by the apparatus.

Fig. 6 shows another form of receiving instrument, which, like the preceding, is a modification of one of Philipp Reis' receivers described in the publications named above, and particularly at p. 1,020 of "Kuhn's Handbook." That instrument, in its original form, consisted of a steel needle or wire, surrounded by a coil of wire, and resting on two wooden supports or bridges over a sounding board of pine wood.

Prof. Thompson now modifies the said instrument in the following manner: He mounts the spiral, s^2, on its bridges, b, b, these parts being made of such dimensions as will permit their inclosure within a case, c, of convenient size and shape, in which he arranges them as shown. He places a thin sounding board, of pine wood or other material capable of vibrating, against the end of the needle, the same being clipped between the case and the cover. The back end of the needle abuts against an iron or steel screw; this screw serves at the same time to hang up the instrument with. The inventor states that he has further discovered

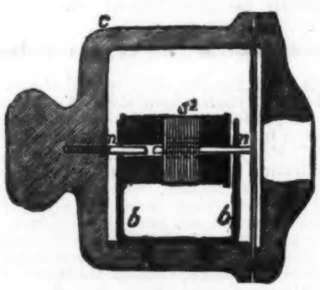


FIG. 7.

that, since the vibrations of the steel or iron needle are due to mutual attractions and repulsions between the molecules, which, occurring simultaneously, set up attractions and repulsions and vibrations in the mass as a whole, their power is increased by giving to the molecules of different parts of the needle a greater play than is permitted by the more elasticity of the needle itself. Accordingly he divides the needle into two parts, each being mounted on its own bridge or support, as shown in Fig. 7, wherein the two parts of the needle are marked n, n, the bridges, b, b, and the spiral s^2.—*Electrical Review.*

SAINT-ANGE DAVILLE'S VOTING MACHINE

AT the Exhibition of Electricity, in 1881, there were two types of voting machines shown, those of Mr. Debayeux and of Mr. Saint-Ange Daville. The first of these we have already described; the second has, since then, been somewhat modified by its inventor, and the latter has now sent us some data that will permit of our describing it.

As well known, the first idea of voting machines dates back to Mr. Martin de Brettes. Later on, Mr. Saigey devised an apparatus of this kind, but gave no description of it, and it was not till 1862 that the first electrical voting apparatus, capable of operating satisfactorily, was constructed in France. This was Mr. Gallaud's apparatus, constructed by Mr. Morin.

In his "Expose of the Applications of Electricity," vol. v., p. 288, Mr. Du Moncel describes this apparatus along with a number invented since. He classes voting machines in two categories: (1) Systems in which each voter has his transmitter and receiver, and in which the recapitulation of the notes is furnished by an apparatus that reacts according to the indications given upon the receivers; and (2) systems in which the votes are expressed only upon the transmitters, and are collected only at the moment of examining the vote, by a machine that is successively put in connection with such transmitters.

Among these latter kinds must be cited those of Mr. Daussin, Messrs. Gaulne and Miide, and of Mr. Debayeux.

The apparatus of the first category, to which belongs that of Mr. Daville, possess parts that are, as a general thing, simpler than those of the others, but their complication is made greater by the number of such parts.

In the system proposed by Mr. Martin de Brettes each voter had two buttons before him on his desk, one of them designed for the vote in favor of and the other for that against. Each of them actuated at the same time an ordinary tablet indicator and a printing electro magnet that marked the voter's name upon a sheet. The receiving apparatus were naturally divided into two groups corresponding to the votes for and against, and the system was completed by a mechanical ball controller. In the apparatus brought out by Mr. Gallaud each transmitter was formed of two buttons, but the receivers were united in the same tablet, and caused a black or white disk to appear in the openings thereof, which were in number equal to that of the voters. The counting of the disks was performed by means of two wheels provided with a finger that traversed a series of contacts. A local current was sent into the counter every time the finger was upon a contact whose circuit had been completed by the fall of a disk. One of the wheels served for the white disks and the other for the black, and there were two receiving dials. Finally, the fall of a disk caused the exit of a point behind the tablet that was differently placed according as it was a question of a black or a white disk. Upon fixing behind the tablet a sheet of paper carrying the names of the voters corresponding with the openings, a hole was in each case pierced, and the position of such hole indicated the nature of the vote.

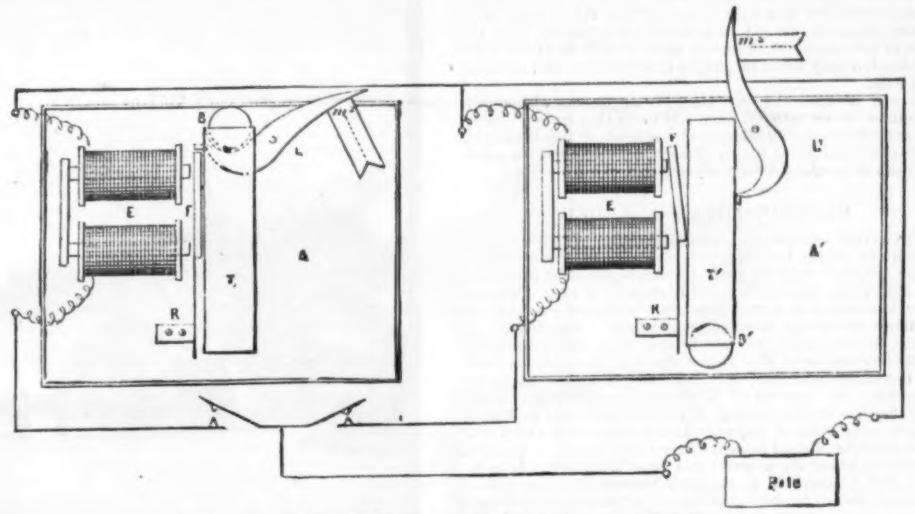


FIG. 1.—DAVILLE'S VOTING APPARATUS.

Messrs. Clevac & Giuchenot's apparatus is on the same general principle, and comprises two tablets—one for and one against; but each receiving electro magnet, at the same time that it causes the appearance of a disk at the corresponding aperture, causes one of the balls contained in a reservoir tube to drop into a collector. The votes are thus indicated upon the corresponding tablets, and are counted by receiving the balls in a graduated tube. The printing of the votes is performed by an electrochemical process by means of two distinct presses for the two different kinds of votes. Each of them is formed of an insulating plate provided with pieces set into it, carrying the names of the voters and connected with the circuits of each of them. Upon this plate there is a sheet of chemically prepared paper, and a metallic strip connected with the return wire. When a disk places itself before its aperture, it immediately closes an electric contact and puts the corresponding name piece in circuit. The name of the voter is then printed chemically upon the sheet.

Mr. Jacquin's apparatus is very analogous to the preceding, and, like it, possesses a totalizer and balls; but the counting is effected by weighing.

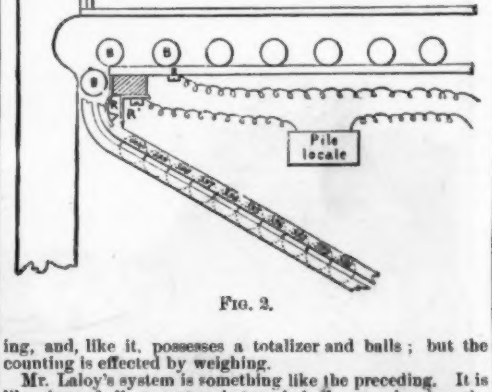


FIG. 2.

Mr. Laloy's system is something like the preceding. It is likewise a ball apparatus, but each ball, upon leaving the collecting tube, sets up an electric contact and causes the needle of a counting dial, which carries as many figures as there are voters, to advance one figure.

We shall not expatiate upon the peculiar arrangements which complete these different systems; it will suffice to have given a general idea of them.

Mr. Daville's system comprises, for each voter, three transmitting buttons, one for votes for, one for votes against, and one for votes not cast.

The distributing apparatus are distributed into three groups—not in vertical tablets, but upon the horizontal surface of three tables. They are analogous in principle to those of the systems above described, but are distinguished by very great simplicity in construction. Fig. 1 represents the apparatus of a voter reduced for more simplicity to two transmitting and two receiving buttons.

Each receiver includes an ordinary call-bell electro-magnet, E, fixed upon a vertical brass plate 8 centimeters in height by 10 in width, and having its armature held at a distance by a spring, R. This armature rests on tube, T, split throughout part of its length, and supports the point of a lever which itself supports a heavy ball, B. When a voter presses upon one of his buttons, he sends the current of his pile (a Leclanche element) into one or the other of his receivers. The armature, being attracted, the lever is no longer supported, the ball drops through the tube, and, at the same time, lifts the external part of the lever, which carries a small flag that indicates the name of the voter. In each table, all the balls thus liberated fall upon an inclined plane, and, as shown in the figure, accumulate in a longitudinally cleft and graduated tube, so that, in order to know the number of votes, it is only necessary to read the number that corresponds to the last ball. The receivers are arranged in rows upon the surface of the tables, and, owing to such a disposition, do not occupy a great amount of space. For the Municipal Council of Paris the surface of each table has to be about 32 centimeters square, for the Senate 1 meter square, and for the Chamber of Deputies 2 meters square. In tables of large dimensions the collecting tube has to be turned spirally around the four legs, so as to have sufficient length to receive all the balls.

It is easy to see that when the voting has terminated the names of the voters will be visible above the surface of each table. In order to put the levers back in place, it suffices to pass over the table a strong rod which puts all their points in connection with their armatures again. In order to proceed with another vote, there is nothing to do then but to provide each tube with its ball. This operation is very simple, and Mr. Daville has, moreover, devised a mechanical arrangement that permits of effecting it in a few instants.

To render the vote secret there is placed upon each table a high cover that leaves sufficient room for the levers to play, and that contains within it the rod for putting the levers back in place. As the rod can be maneuvered from the exterior, the secrecy of the vote is secured with certainty.

Through an arrangement analogous to that that we have pointed out in the Laloy apparatus, each ball, upon entering the collecting tube, causes the springs, R and R', to touch against one another, and closes a local circuit that actuates a counter having three dials. These latter are arranged in a tablet possessing three apertures, and consequently never allow but three figures to be seen; so that the number of votes can be read at once. But the most original part of Mr. Daville's apparatus consists in the printing of the votes, which is effected by utilizing the work produced by the fall of the balls upon the inclined plane. Fig. 3 shows the arrangement adopted. Two or three centimeters above this plane, F, there is a second one, M, movable behind and in front, and suspended by four rods of equal length that are jointed at their extremities, so that, upon drawing toward one's self this movable plane, one forces it at the same time to rise, horizontally. Exactly beneath each of the lower

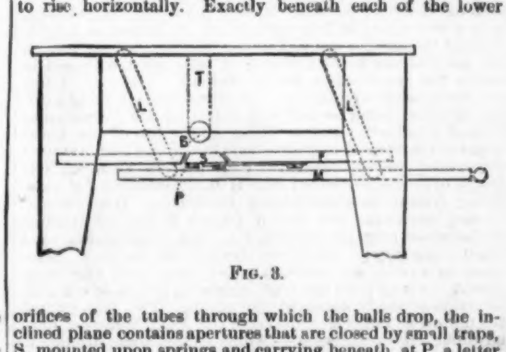


FIG. 3.

orifices of the tubes through which the balls drop, the inclined plane contains apertures that are closed by small traps, S, mounted upon springs and carrying beneath, at P, a letter in relief, such as C, P, or A, according to the table. If, now, there be made to slide between the stationary inclined plane and the movable one a strip of wood covered beneath with felt saturated with an oily ink, and if the movable plane be pulled two or three centimeters forward, the latter will be caused to rise at the same time and ink the letters which are beneath the traps. The movable plane is then immediately allowed to fall back, and the strip of wood that carries the fatty ink is taken out and replaced by another one which has been previously prepared, and upon which lies a dry piece of felt, and over this a sheet of paper upon which are printed the names of the voters in the same order as in the previously mentioned apparatus.

These preliminary arrangements take scarcely more than a minute. The apparatus being thus prepared, as soon as the balls fall upon the traps of the inclined plane they [illegible] them to drop suddenly, and the letter that they carry in relief charged with ink leaves its indelible imprint upon the paper alongside of the name of the voter. As soon as each

person has voted, the sheets are taken out and handed to the person whose duty it is examine them, and the empty tubes are then provided with balls again.

The votes may thus succeed each other nearly every five minutes. Aside from the fact that a quick and very accurate account of the vote may be taken, it is, for the numbers, a fourth element of control. The preparatory operation of printing lists may be performed more quickly yet, and the work of putting in and taking out the piece of wood and its felt saturated with ink may be avoided by causing the inclined plane that carries it to rise or descend to the desired distance by means of a central screw placed beneath, and afterward causing the piece that carries the printed sheet (which should be stamped with a P, a C, or an A, according to the table) to slide upon lateral supports. Aside from the fact that a little time is gained by this method, a means is obtained of regulating the distance between the stationary and movable planes, this being something that may have its utility at a given moment. Finally, the inventor has foreseen the possibility of voters causing one of their balls or even all three of them to drop before the vote, through pressing either inadvertently or intentionally upon the buttons placed upon their desks. In order to avoid such an inconvenience it is only necessary that the ground wire of the apparatus be led to a commutator placed upon the table of the president, who will thus be able to give a communication only when he judges it opportune, and to break it at will.

It will be seen that Mr. Daville's apparatus, although it resembles in its general principle those that have preceded it, nevertheless merits attention by reason of the simplicity of its parts and of the happy arrangement adopted for printing the votes.—*La Lumière Electrique.*

GLASGOW BOTANIC GARDEN.

Notwithstanding the boasted position which "canny" Scotchmen claim for Glasgow as being the "second city in the empire," both its great commercial sisters in wealth and enterprise, Manchester and Liverpool, if they have not more interesting or better appointed botanical gardens, are far more successful, financially speaking. Manchester, of course, fifteen years ago was in very deep water until the spirited enterprise of Mr. Bruce Findlay, with a strong will and indomitable perseverance, pulled his company out of the quagmire. By a series of Whitsuntide exhibitions which have become world-famous, the shillings of the multitude in these busy hives of industry in the Lancashire and Yorkshine districts flowed into, we have no doubt, a grateful Chancellor of the Exchequer; and now Manchester is reckoned, and no doubt it is, the most successful unsubsidized botanical garden in the kingdom. The garden at Liverpool is taken in hand by the municipality, and consequently wants for nothing in the way of good keeping. Of course all municipalities, are apt to be niggardly, because they have to face their tax-paying constituents and give an account of their stewardship, but be that as it may, the curator and his staff are certain to be supported in a very different way from a private company that cannot even pay the interest of their debt. The Glasgow garden happens, as will be seen from the last published balance-sheet, to owe the Corporation £40,000, and it is quite obvious that it is only a question of time when it will pass under municipal rule; and the sooner the better, too, every lover of horticulture will say. The £40,000 has been spent for some purpose: for, 1st, the grand Winter Garden, known formerly as the Kibble Conservatory, has been acquired; and 2d—even more important still—a set of houses 320 feet long, with a short range at other end at right angles, of 105 feet each, varied in width to suit the subjects set down as a sort of permanent tenants, has been built of teak-wood by Messrs. James Boyd & Sons, and thoroughly equipped in every respect internally for varied plant life; and it is to these houses that I wish to direct your readers' attention.

Beginning at the tail-end of our subject first, these teak houses, quite recently finished, do not present externally much of an ornate character. There is nothing at first sight that would indicate an expenditure of £10,000 about them, but when the sightseer gets in and about them his opinions are sure to change. Everything done is so good and substantial, the Caithness pavemented passages, the Welsh slate tables, the piping, ventilation, and general fittings at once indicate that the designer of the range insisted upon generally useful structures, combined with extreme durability. None of the houses are too lofty for their inmates, and but for the great mistake of making the Victoria Lily house or tank from 6 to 10 feet too small in diameter, which is a unfortunate oversight—better have had no Victoria house at all—the range would, horticulturally speaking, be as nearly faultless as possible.

In the center of the range is the Palm house, 85 feet deep, with a frontage of 55 feet, and 43 feet 5 inches in height. Around the interior are shelves for smaller palms, and in the body of the house a couple of beds filled with soil in which the large palms are planted out. The roof of this house was purposely kept low, as palms after attaining a certain altitude cannot be well seen unless by the formation of a series of galleries; and by filling up the top of the house with their leaves, and they also shade the smaller plants around them, and thereby prejudice their healthy growth. The height of the house erected here is quite sufficient for exhibiting typical moderately-sized specimens. With efficient heating apparatus one special feature in the construction of the house may be noticed, viz., the introduction of a small heating pipe round the lantern of the roof. This great improvement it has been found stops to a very large extent the drip from the roof, which in houses of old construction seriously damaged the plants. The boiler house for the whole range is underneath the Palm house—a most advantageous arrangement— which caused some trouble in construction, as a ventilation drain had to be driven from it under the Ewing range to the bank of the Kelvin. The latter range forms a nucleus for supplying the new range, and for nursing onward bedding plants and similar plants.

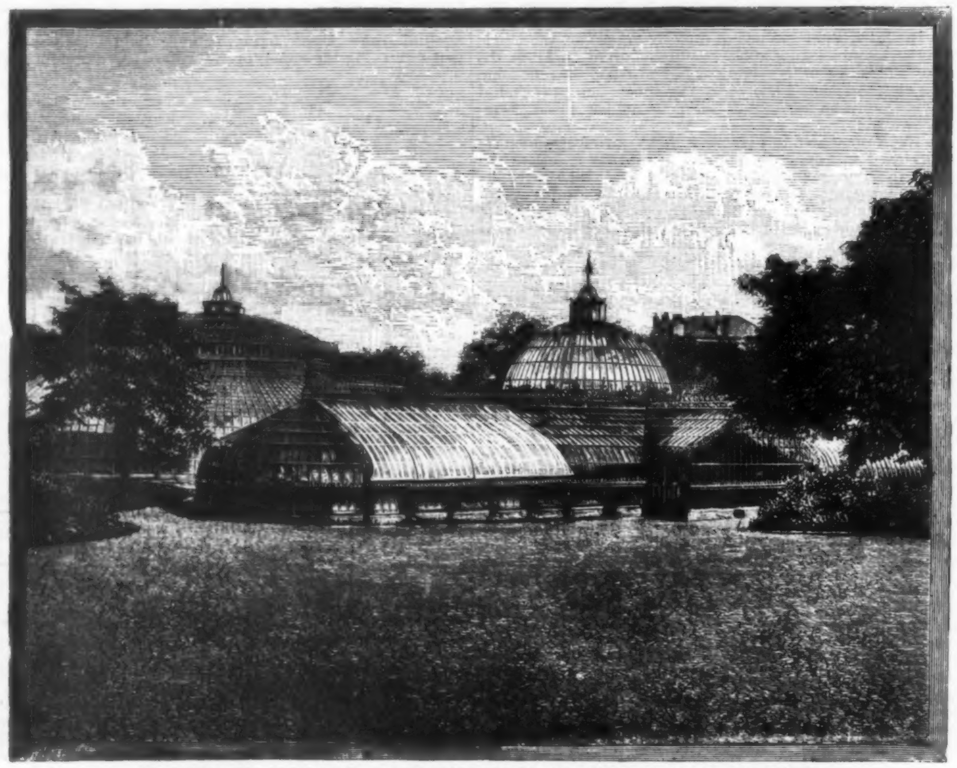
The principal subjects in the Palm house comprise Borassus flabelliformis, with its beautiful shining green leaves, making a capital fellow to the well known umbrageous Latania borbonica; so also does the round-leaved Livistonia (L. rotundifolia), fronted with great plants of Fourcroya cubensis and argentea. In the nooks and corners are noble plants of the prominent Zamia horrida, and several handsome tufts with woody crowns of various Macrozamias. These, along with towering plants of Seaforthia elegans and Livistonia sinensis, with no end of smaller palms round the side tables, make an interesting tropical house. These are two central beds, each 15 feet in width, and the path between grated, to allow the heat to ascent from stack of pipes underneath, with a solid looking stone curb to form the borders. The side tables are of Welsh slate, and in order to husband moisture for atmospheric purposes, a layer of cocoa-fiber rests on the tables, into which the pots of palms, etc., are plunged.

The house on the east side of this is the succulent house—possibly, next to Kew, the best appointed house for species and varieties in the kingdom. Most of the plants are in capital health, and Mr. Bullen has them arranged according to groups, which is important for the student and for the general sightseer. In the center bed are very prominent plants of Agave salmiana, and many others, among which was the rarer Mexican variety with short, elegant, sword-shaped leaves of fine glaucous surface, and quite a host of ornamental agaves, among which we noted applanata, univittata, ixtli, ixtlioides (very distinct), attenuata glauca (with broad, concave leaves of the most captivating green), macrantha, lindeni (very beautiful, from having an irregular prominent silver margin adorned with short, stumpy spines). These margined with Beaucarneas, Yuccas, Dasylirions, Opuntias, Fourcroyas, and many others of the grosser growing succulents, render this house one of the most important in the range. By the way, not the least prominent of this center group was a grand specimen of Aloe platylepis, with four highly ornamental Tritoma uvaria-like spikes, towering above its fellows. On the side benches the groups were specifically distinct, first coming Euphorbias, then Opuntias, Fourcroyas, Mesembryanthemums, Echinocactus, of which Leopoldi, with its fierce looking spines, stood out distinct; and then Phyllocactus in numerous sorts—none, however, at this season more stylish looking than P. anguligera with flowers studded along both edges of leaves like beads, then Crassulas, Sedums, Cotyledons, Echeverias, Agaves, Rhipsalis, Beaucarneas, Pilocereus, Echinopsis, Yuccas, Gasterias, Cereus, and among them C. Tweedei is the most ornate, standing up like a column of stone; Haworthias, Mammillarias, and Aloes, of which there is a fine assortment. This in time will prove to be both an interesting and instructive houseful.

On the west side is the economic house, of similar dimensions in every way. Chief among the lot in the center is Heritiera littoralis, with a stem as straight as a gun-barrel carrying very large ovate leaves with very prominent venation; then the wild Banyan tree (Ficus indica), the Anchovy Pear, the Cinnamon as well as the Ginger and Chocolate plants; the Indian Fig tree (Ficus eburnea), with handsome obovate leaves and singularly prominent white venation; the Coffea liberica, much larger and stouter than the common C. arabica; the Clasia grandifolia with stiff leaves, and as concave as a saucer, and many other medicinal and useful plants, such as tea, sugar, quinine, guava, mango, etc., all in good order, having plenty of space for extending themselves.

Adjoining this is the stove fernery, full of fine fresh foliage. In it were Drynaria, morbillosa, Asplenium Gardnerianum, a fine pot fern, and Asplenium scandens, with lots of maidenhairs in their many forms; the handsome Nephrolepis davalloides, a grand mass of Microlepis hirta cristata, and some climbing Lygodiums. Suspended from the roof were several tropical orchids, which always revel in the plethora of moisture arising from such a lot of greenery. Saccolabium giganteum and several moth orchids (Phalænopsis) were evidently enjoying life in this climate.

Next to this again is a high temperatured house, with several specimens of Eucharis, Crinum, the large leaved Acalypha, the pretty rose painted Phyllanthus (P. rosea picta), a handsome and useful plant for botanic gardens. The many forms which these exotic plants take on is interesting to ob-



THE KIBBLE CONSERVATORY IN THE GLASGOW BOTANIC GARDEN.

THE NEW RANGE OF PLANT HOUSES IN THE GLASGOW BOTANIC GARDEN.

serve, and it is chiefly in such gardens as I write about that the public can see such things. Here the Aralia umbraculifera shows up its foliage crowded in whorls, and the leaves ovate and plain—so different to many of its compeers; and then again the Columbian Maranta sanguinea at once arrests attention from its leaves throwing, as if it were on second consideration, great footstalks 2 or 3 feet long, which are surmounted with tufts of smaller leaves, and all nicely colored. Crotons in variety, Pandanads, and Dragon's blood plants give color and variety to the group.

At right angles to this is an intermediate house in which orchids live among other plants, but are not in quantity such as many people would desire to see. Still, there are many nice Dendrobes, some capital moth orchids—the spotted and barred leaved Schilleriana being in excellent style; and so are several Cattleyas, Roezl's Odontoglot in fine flower and clear and vigorous. Among the grosser growing lot are masses of Eucharis in fine flower, the fasciculated Hæmanthus with its highly ornate spotted stem, some of the newer Crotons, the exceedingly grotesque-looking Philodendron crinipes, with the center lobe of the leaf saddle shaped and having two ear-like reniform wings at the base, etc.

The circular house, which forms the extremity of the range in the east, is the Victoria house, which is fitted up in every way to suit water plants, but not to give space for the Victoria leaves, which in summer not only extend over the wall of the tank, but get on to the path. This along with Nymphæas and other water plants fully occupied the spatula-like formed tank; on the side stages are orchids, bromeliads, and some other ornamental plants. It may be stated that, notwithstanding the cramping of the Victoria, it had thirteen flowers expanded last season.

The houses east of the succulent house are chiefly filled with New Holland plants and azaleas, of which there is a large and well managed lot. These, with the denser growing Himalayan rhododendrons, occupy the larger house in the east wing in which the visitor generally enters.

At right angles are the cool orchid house and the green house fernery. The stock of orchids is only limited, and it only seems a pity that Mr. Bullen, who always has been a keen orchidophilist, should not have more of them to cultivate. As it is, there are, among the Odontoglossums, Crispum, Pescatorei, nebulosum, a grand lot of Oncidium varicosum growing and flowering magnificently, suspended in baskets and otherwise in this cool house, in which also were lots of Ladies' Slippers, the finely fringed Dendrobium fimbriatum in mass of bloom, as also Cœlogyne cristata, and the sweet-scented Trichopilia and many others. Among the ferns are Pellæa ornithopus, the handsome Gymnogramma triangularis and Pteris straminea, Lastræa tenericaulis, with prominent pinnatifid frondage; the singular Goniopteris refracta, with fronds opposite, and leave entire; Alsophila Williamsii, Balantium Culcita, Nephrolepis umbrosa, etc.

In addition to this range are four span-roofed houses detached for propagating and other purposes, each about 40×12 feet. The whole range is heated by two of Bullen's 8-foot Glasgow boilers, to which are attached about 2 miles of 4 inch piping, and they seem to do their duty well, and could do more, we understand, if required.

Not to speak of the Ewing range, nor of the most interesting shaded house for filmy ferns and mosses, we proceed to take some notice of what is known as the Kibble Conservatory, which was also built by the Messrs. Boyd, and by them remodeled about three years ago. As you enter there is a spacious pentagonal corridor, with a span roofed house at either side, that is, at right angles, of 40×22 feet. On the one side is a nice collection of heaths, with the front stages covered with plants in bloom, such as Primulas, Cinerarias, etc. In the corresponding house are New Holland plants with Epacris in flower, and lots of Acacias; while in addition to the climbers of ordinary cast in the corridor is Lonicera fragrantissima, with good-looking ovate leaves set opposite each other on wiry-looking stems—a very good plant for a full house. The Kibble proper is circular, with a border of 10 feet wide, then a path 14 feet wide, then a bed 16 feet in width, then a path, and then the center. The coolness of the climate has given an immense impetus to the growth of the tree ferns since they were planted some two or three years ago. Among them are quantities of Cibotium Schiedei, Dicksonia antarctica, some of them with 10 foot stems; the grand distinct Cyathea dealbata, Alsophila prænitens, Moore's Todea barbara, as dark green as a Scotch leek; Dicksonia Smithii and D. regalis in extra fine cut frondage, the Chinese Cibotium Barometz; these, along with some smaller fry, fill up the center, which is about 40 feet diameter.

On the border surrounding, warded off by the path, are some grand specimens of Cibotium princeps, with great chaffy rachis and beautifully formed opposite leaves, the pinnate fronds turning up and forming a splendid outline for the eye to rest upon. Then the Sikkim rhododendrons, towering up, some of them toward the lofty roof, studded with buds in such quantities as will make a display in spring worthy of going a day's journey to see. This is the place for such gigantic species as Nuttallii, Jenkinsii, Dalhousianum, and such leggy fellows as ordinary growers cannot provide accommodation for. Among them are several acacias, the New Zealand flax, a noble plant of Astrapæa Wallichii covered with bloom, hosts of camellias, the Eucalyptus globulus, Araucaria Bidwillii and A. excelsa, together with several palms of the Kentia race. Unquestionably this is one of the finest promenades, covered with glass, where plants have been collected to show their growth, proportions, and beauty, that I have ever had the privilege to see. In time past, as a *quasi* singing saloon, and a meeting place for entertainments of various sorts, it turned out practically a failure; as a great plant house, capable of showing what Nature in that way can produce, it promises to be an abundant success. The grounds have been remodeled, and the garden seems to be well appointed in every way.—*A., The Gardeners' Chronicle.*

VIEW IN THE KIBBLE CONSERVATORY, GLASGOW BOTANIC GARDEN.

THE LARCH WORM.

FOR three summers past the existence of the larch, hackmatack, or tamarack in the northern portions of New England, New York, and portions of New Brunswick and Canada, has been threatened by a saw-fly larva. This proves to be the *Nematus erichsonii*, as the transformations, habits, and imago appear to be the same. From Ratzeburg's description, the habits of the American worm are evidently like those of the European species, and it is very probable that the insect is common to both Europe and Northeastern America. At any rate, our species could not have been introduced with European larches, since its ravages have been committed in the wilder, less frequented portions of Maine, New Hampshire, and New York, as well as on the seaboard in towns long settled. In brief, the habits of our species are as follows: The eggs are laid in the terminal young shoots of the larch from about the middle of June, in Massachusetts, to the early part of July in Northern Maine, the larvæ feeding on the leaves late in June and in July and early August. By the last of July to the first week in August, according to the latitude, the worms are nearly full grown, while a few half-grown ones occur on the trees in Maine in the last week of August and the early days of September. It is very doubtful whether they are two broods. We will now give a more detailed account of its habits, from a report on the causes of the destruction of evergreen forests extracted from the forthcoming annual report of the Entomologist, Department or Agriculture, 1883.

The eggs had all hatched by June 23-28; few were to be found at Brunswick, although the incisions made by the female were commonly observed. The female saw fly makes about a dozen incisions in the terminal young, fresh, green shoot, sometimes in one of the side shoots next to the terminal one; judging by the shape of the whole, the eggs are of the shape described by Ratzeburg, *i. e.*, oval cylindrical and about 1·5 mm. in length. The eggs are placed in two rows, alternating, not exactly parallel, one being placed a little in advance of the other. The eggs are inserted at the base of the fresh, soft, young, partly developed leaves of the new shoot, which is usually by June 20-30, only about an inch or an inch and a half in length. The presence of the eggs caused a deformation of the shoot, which curls over, the incisions being in all cases observed on one (the inner) side of the shoot. In many cases a last year's shoot was observed with the scars of the incisions on the concavity of the shoot. That the incisions were made by the saw fly was proved by finding a freshly hatched, but dead, larva in one of the holes. Sometimes one or two of the leaves die in consequence of the wounds made at their base.

Fig. 1.

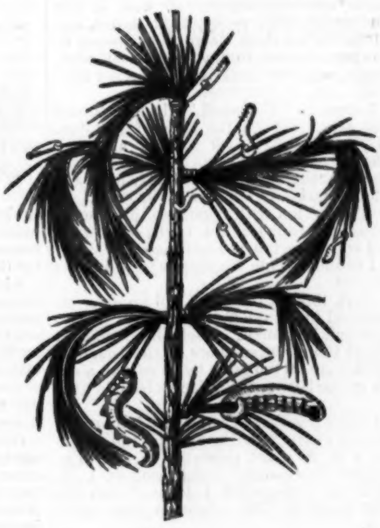


Fig. 2.

FIG. 1.—The larch saw-fly, nat. size and enlarged. FIG. 2.—The larch worm of different ages, nat. size. Miss L. Sullivan, del.

After the foregoing lines were written we fortunately observed a female in confinement, June 29, while engaged in the process of ovipositing; we should judge that the operation of sawing the slit and depositing the egg required not less than five minutes, and perhaps not much more than that length of time. The fly had been evidently at work for some time previous, as a number of eggs had been laid along the shoot; she had begun at the farther end, and worked down to the base of the new, fresh, green shoot. She stood head downward while engaged in making the puncture, and was not disturbed by our removing the larch twig from the glass jar, and holding it in our hand while watching the movements of the ovipositor under a Tolles triplet. The two sets of serrated blades of the ovipositor were thrust obliquely into the shoot by a sawing movement; the lower set of blades was most active, sliding in and out alternately, the general motion being like that of a hand saw. After the incision is sufficiently deep, the egg evidently passes through the inner blades of the ovipositor, forced out of the oviduct by an evident expulsive movement of the muscles at the base of the ovipositor. The slit or opening of the incision after the egg has passed into it is quite narrow and about 1½ mm. in length. While engaged in the process the antennæ are motionless, but immediately after the ovipositor is withdrawn they begin to vibrate actively, the insect being then in search of a site for a fresh incision.

After making the foregoing observations, we found at Phillips, Me., July 1, and at Errol, N. H., July 4, numerous twigs containing eggs, and the flies were also observed upon the trees ovipositing. Although the slit is at first closed, as soon as the embryo increases in size the twigs swell where they have been incised by the ovipositor, and the slits enlarge or gape more or less, becoming much larger and more conspicuous than when the eggs are first deposited. It would thus appear that oviposition takes place about a week later in the vicinity of Brunswick, Me., than in Essex County, Massachusetts, and about a week later in Northern Maine and New Hampshire than on the coast at Brunswick.

When the larva hatches the incision gapes open, leaving an oval hole. Out of this gape the larva creeps, and it rarely eats the terminal shoot, but crawls upon the leaves of the whorls next to the terminal shoot. At first it nibbles one side of the needle or leaf, leaving it half eaten and rough, serrate, and partly withered along the edge. The half eaten, withered leaves of unequal length in a whorl on the ends of the smaller branches enable one to detect the presence of the young worms on the tree.

Usually after the young larvæ have shed their first skin, they collect on the verticils of the larch, and almost invariably begin to eat the needles, one after another, beginning at the distal end and eating the leaf obliquely until only a short stump is left; in this way one verticil after another is eaten, and when the worms are half grown they occasionally collect around the main stem of the twig in singular clumps or clusters, the hinder part of the body curled over their backs, and, owing to their oblique posture in reference

to one another, appearing like a ball of worms. This singular appearance was briefly noticed by Ratzeburg. The castings or excrement are long, cylindrical, more or less truncated at each end. Our saw fly differs slightly, as has been described, from the German in the eggs being laid at the base of the leaves on the newly grown shoots, rather than on or just under the epidermis of the last year's shoots, where we have repeatedly and in vain searched for them. The larvæ were observed to hatch out from June 20 to 30 at Brunswick, Me.

The worms appear to attain their full size in about five to seven days after hatching; certainly less than or not more than ten days. There appear to be but three molts or changes of skin, *i. e.*, four stages of the larva. In casting the skin the head splits open along the median line of the vertex, and the epicranium or sides of the head split apart on each side, leaving the clypeus and labrum in place; then the body is drawn out of the rent, the skin adhering to the needle or leaf.—*A. S. Packard, Jr., Amer. Naturalist.*

[SCIENCE.]

THE NEW BOGOSLOFF VOLCANO IN BERING SEA.*

ON Tebenkoff's chart of Unalashka Island, and the adjacent passes from Unimak to Umnak Islands, there is placed in latitude 53° 51′ north, and longitude 167° 40′ west, an islet about half a mile in extent, with rocky, bold shores, and somewhat flattened top. It has deep water close around it, and no outlying dangers except to the north-northwest, where a small "pinnacle rock," or "sail rock," lies a few hundred yards distant.

The rocky islet is known as "Bogosloff." In his account of his voyages,† Cook says, that on the 29th of October, 1778, he discovered "an elevated rock which appeared like a tower;" and he judged of its steepness below the surface of the sea by the circumstance that the sea (which was running very high) broke nowhere but against its sides.

I have plotted Cook's position with regard to this discovery, made when he was only four leagues to the southwestward of the islet, and was steering a northeasterly course. From his language, I cannot decide whether he passed on its northern or southern side.

His footnote says that, though this mass had no place on the Russian map produced by Ismyloff,‡ it was indicated on the chart of Krenitzen and Levasheff. Cook placed it about seventeen miles north of the northern shore of the island of Umnak. His longitudes are all too great by more than a degree, but the relation of the islet to the adjacent islands fixes its position.

This reference to Cook's position is somewhat important; because, on an admiralty chart of Bering Sea and the Arctic Ocean (1859), and on a U. S. chart corrected to 1868 (Exploring expedition under Commander John Rodgers, U. S. N.), this islet is called the "Bogosloff volcano;" and the statement is made that it rose in 1796—eighteen years after Cook had described it.

Tebenkoff, in 1848 (perhaps following Saricheff in 1829), calls it "St. John the Theologian Island," or, rather, "rock," and gives it a circumference of two miles. According to Saricheff, its height is about four hundred feet; but the navigators of the Russian American company made it six hundred and twenty feet. Tebenkoff says Pillar Rock lies four hundred yards north-northwest of Bogosloff Island.

On the admiralty chart and on some of the Russian charts (including those of Saricheff), and even on the chart published by the U. S. hydrographic office in 1855, a dangerous reef is laid down between Bogosloff and the northern end of Umnak. The U. S. chart, corrected to 1868, repeats this danger; and it is even laid down on the U. S. circumpolar chart of 1882. Tebenkoff says this "dangerous reef" does not exist: Veniaminoff says the natives deny the existence of the reef, but report great current or tide rips, which are dangerous to their bidarkas. In 1867 I had the same information from the Russian priest Shayesnikeff—a man of more than ordinary knowledge and capacity, and well acquainted with the islands, which he visited regularly in the course of his ministrations; also the Alaska commercial company's navigators have passed between Umnak and Bogosloff islands. Neither the Bogosloff, the reef, nor the northern part of Umnak is on Kotzebue's chart of 1817.

The height of this volcanic island varies according to the authority from which the estimate has been obtained, as already indicated. Tebenkoff gives estimates, from two authorities, of four hundred and six hundred feet. On my chart I have a note stating the height to be eight hundred and forty-four feet, but I had forgotten to state the authority for that estimate. I suppose that I obtained it from one of the Russian navigators, in 1867. The captains employed by the Alaska commercial company, however, estimate the height at from two hundred and fifty to three hundred and fifty feet.

Of this islet I collate the following facts, without examining many authorities:

1778.—Cook saw it, Oct. 29, in clear weather. He says it is on the charts of Krenitzen and Levasheff.

1796.—Veniaminoff, calling it "St. John the Theologian," states that it arose out of the sea on May 7 of this year; and that, at the time, there were, according to Krusenstern and Langsdorff, earthquakes and eruptions.

1800.—It was smoking (Kotzebue).

1802.—It was smoking (Langsdorff). (At that time the volcano Makushin was throwing out volumes of smoke and fire.)

1804.—It was smoking from one crater (Kotzebue).

1806.—The burning lava was flowing down the north side (Langsdorff).

1814.—The crater threw out stones (Baranoff).

1815.—It was diminishing in height (Baranoff).

1816-17.—It had no activity (Eschscholtz).

1820.—It was smoking (Dr. Stein).

1823.—It was not smoking (Veniaminoff).

1832.—There was no smoke (Tebenkoff, Lutke).

Although frequently seen in later years by the navigators of the Russian American and Alaska commercial companies, and by the whalers, no one has noticed it as exhibiting any signs of activity.

In another part of Veniaminoff's work, in giving more particulars of earthquakes and volcanoes, he writes:

"The new island, Bogosloff, in latitude 53° 58′ north,§ and longitude 168° 5′ west, rose from the sea in the early part of May, 1796. Before the island appeared above the sea, there had been witnessed, for a long time in that spot, a column of smoke. On the 8th of May, after a strong subterranean noise, with the wind fresh from the northwest, the new small, black islet became visible through the fog; and from the summit great flames shot forth. At the same time there was a great earthquake in the mountains on the northwest part of Umnak Island, accompanied by a great noise like the cannonading of heavy guns; and the next day the flames and the earthquake continued. The flames and smoke were seen for a long time. Many masses of pumice stone were ejected on the first appearance of the island."

At that time it was, perhaps, only one-quarter the size of its present dimensions; and it increased in size, growing higher, and breaking down at the same time on all sides. Finally, about 1823, it seemed to become unchangeable. Until it ceased to increase in size, it was hot, as well as the sea water around it; while smoke and steam arose from it continuously.

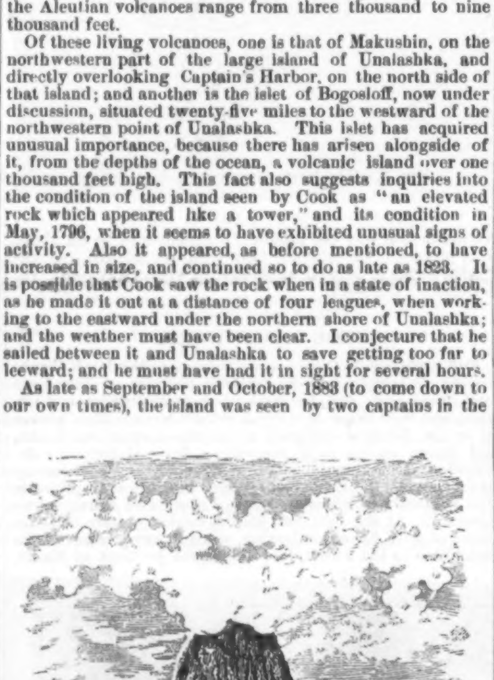
It is noticeable, also, in this connection, that Krenitzen and Levasheff, who made the voyage of discovery in 1768 and 1769 to endeavor to discover the track of Bering's voyage, have marked Bogosloff on their chart as situated forty miles west by south of Makushin volcano, and surrounded by sunken rocks. Their mark is a view (see sketch), and clearly indicates the peculiar shape of the islet at that time. Their course led them ten miles to the northward of it. So much for the older authorities.

BOGOSLOFF ISLAND, DISTANT TEN MILES, AS SEEN BY KRENITZEN AND LEVASHEFF, 1768–69.

Along the whole chain of the Aleutian Islands, from abreast of the Kamtchatka peninsula to the head of the peninsula of Alaska, there is a line of the greatest volcanic activity exhibited by about fifty volcanoes, of which many are living, and of which some are at times in a state of violent eruption. Some of them have an extreme elevation of about twelve thousand feet on the Alaska peninsula; while the Aleutian volcanoes range from three thousand to nine thousand feet.

Of these living volcanoes, one is that of Makushin, on the northwestern part of the large island of Unalashka, and directly overlooking Captain's Harbor, on the north side of that island; and another is the islet of Bogosloff, now under discussion, situated twenty-five miles to the westward of the northwestern point of Unalashka. This islet has acquired unusual importance, because there has arisen alongside of it, from the depths of the ocean, a volcanic island over one thousand feet high. This fact also suggests inquiries into the condition of the island seen by Cook as "an elevated rock which appeared like a tower," and its condition in May, 1796, when it seems to have exhibited unusual signs of activity. Also it appeared, as before mentioned, to have increased in size, and continued so to do as late as 1823. It is possible that Cook saw the rock when in a state of inaction, as he made it out at a distance of four leagues, when working to the eastward under the northern shore of Unalashka; and the weather must have been clear. I conjecture that he sailed between it and Unalashka to save getting too far to leeward; and he must have had it in sight for several hours.

As late as September and October, 1883 (to come down to our own times), the island was seen by two captains in the service of the Alaska commercial company—Hague and Anderson—both of whom called upon me, described the character of this new formation, and enabled me to make a rough sketch of the islet as it appeared to them (see view). They both passed close to it, approaching from opposite sides, and thus were enabled to judge of its size, height, and general appearance. Capt. Anderson, in the schooner Matthew Turner, saw the island at daybreak (five A. M.) on the 27th of September, 1883, and passed it at half past eight A. M. within three cables' lengths; heaving the lead as fast as practicable, with twenty fathoms of line, and finding no bottom, although the water was discolored and of a red color. The vessel first approached it on the eastern side, stood up to the northwestward, tacked ship, and passed to the westward. The islet was surrounded by white smoke, like steam. The same evening, after nightfall, being then about twenty-five miles to windward of it, they saw the fire on the island.



THE NEW VOLCANIC ISLAND OF BOGOSLOFF, AS SEEN SEPTEMBER–OCTOBER, 1883.

On the 27th of October, 1883, just one month after Anderson's visit, Capt. Hague, of the Dora, saw the island at seven A. M., approaching it from the southwestward (just as Cook had done one hundred and five years before). He first passed through a streak of red water into a green streak beyond it (the water under both conditions having the appearance of being very deep), but, fearing shoals, tacked ship to avoid a nearer approach. He came no nearer than about one mile, and had the island in sight about three hours. At that time there was black smoke issuing from it, as if tar were burning. The weather was cloudy, and no observations could be had for position; but its proximity to the old Bogosloff fixes it with equal precision.

Both captains agree in saying that the island is larger than the old one, and is about half a mile north-northwest of it; that it rises very steeply, with a rough, ogee curve; and that the outline on the eastern side is broken on the shoulder and at the base by masses of rocks (see view, above). On the western side there is a level space just above water, and thirty or forty feet in extent, where a landing could be effected. The top was hidden by clouds; but white smoke or steam could be seen issuing from near the cloud line, which was estimated to be from eight hundred to twelve hundred feet above the sea. The sides are very steep; and, apparently, it has arisen from the depths without developing outlying dangers, because, with a heavy swell running, no breakers were seen. Around the base are great steam jets, somewhat like those near the summit. At night it looks as if the whole islet were in active eruption, and covered with fire (this may arise from the ignition of gases escaping from innumerable apertures in the flanks of the islet).

Tebenkoff, in his description, tabulates this islet as in latitude 53° 52′ north, and longitude 167° 39′ west.

I have no doubt that during the present year (1884) we shall obtain its exact geographical position, its physical conditions, and reliable measures of its size and height.

On the 20th of October, 1883—seven days before Hague saw the island—a shower of ashes took place, small quantities of which were collected at Iliuliuk, and a portion presented to the California Academy of Sciences. There seems some doubt, however, as to the point whence the ashes came; as the account from Iliuliuk places the date of their fall at Oct. 16, *wind being fresh from west-southwest*, with rain and sleet. It may be that this pumice dust came from the eruption of Mount St. Augustin (see map of Alaska) on Oct. 6, under the influence of an upper current of air from the northeastward; that mountain lying over seven hundred miles distant in that direction from Unalashka.

It is noticeable, that during the eruption from Bogosloff, or at least about that time, the two volcanoes on Akontan Island (about as far to the east-northeast of Makushin volcano as Bogosloff is to the west by north) ceased to smoke, and showed no signs of activity. These two volcanoes, only three miles apart, are 3,332 and 3,888 feet high respectively. Nothing was heard from Makushin; probably its summit was in the clouds, and might have been active.

As regards the distance to which the ashes from such eruptions are sometimes carried, it may be mentioned, that at the time of the eruption of volcano Iliamna, in March, 1867, the pumice ashes fell on St. Paul, Kadiak Island, one hundred and sixty-five miles distant.

From the natives of Iliuliuk it was quite recently learned that they had seen smoke issuing from the new Bogosloff—or, rather, from the position of the Bogosloff—some time in 1882; the exact date could not be obtained.

GEORGE DAVIDSON,
Assistant, U. S. Coast and Geodetic Survey.

LENGTH OF TIME DURING WHICH AEROLITES ARE VISIBLE.

I SHALL not go back to the evidently fabulous narratives that certain writers of antiquity have left in regard to these phenomena—back to the narrative of Damachus, for example, quoted by Plutarch, and according to which a flaming cloud was seen giving forth sparks like shooting stars for *sixty-nine consecutive days*, and then descending, and ending by shooting out the famous Ægos Potamos stone, one of the most ancient meteorites mentioned in history.

In the long enumeration of aerolites given in Arago's Popular Astronomy, from the year 91 B. C. up to 1853, I find but one mention of a somewhat lengthy duration, and that was the one of May 5, 1819. "At half past twelve," says he, "during perfectly clear weather and while the sun was shining brightly, there was observed at Aberdeen, Scotland, a globe of fire that had a sort of tail. *Five minutes* after its appearance it exploded with considerable noise." The aerolite of the 19th of July, 1686, of which Arago cites only the date, and which appeared at Leipsic, is described by Halley as having been visible for several minutes.

In the conclusion of Biot's report upon the celebrated fall of stones of the 26th of April, 1803, which covered a space of two and a half leagues long by nearly one wide, we read the following: "There occurred in the environs of Aigle, on the 6th of Floreal, year XI., toward one o'clock in the afternoon, a violent explosion that lasted for five or six minutes, with a continuous rumbling; . . . a few minutes before the explosion there appeared in the air a luminous globe which had a rapid motion." According to the very detailed circumstances and the witnesses cited in the report, the duration of the explosion did not coincide with that of the appearance of the globe of fire. The latter was not seen throughout the entire extent of the country where the explosion was heard. At certain points nothing was seen, and the heavens were clear; at other points only a small black cloud was observed, and this seemed to be immovable and to give forth a noise similar to that of thunder. From the duration of the noise, then, we can scarcely judge as to the duration of the visibility. There are two reasons for this: the first is due to the time that it takes sound to move through the air, and which contributes to increase the real duration of an explosion that occurs successively at different distances from the observer; and the second is that upon which Biot dwells in these terms: "If the observations made upon the duration of the noise could be regarded as accurate, we should deduce the horizontal velocity of the meteor from the ellipticity of the extent over which the stones were thrown; but I do not know whether any precise observation was made upon this point, and, as regards this, we can only rely upon the accuracy of instruments, since astonishment always leads us to increase the duration of a phenomenon whose continuity causes us some surprise."

I now come to more recent documents. Persons who are engaged with astronomical questions know that there is a committee in England which is specially charged with the study of luminous meteors, and which consists of Messrs. Glaisher, Greg, Brooke, Forbes, Flight, and Herschel. The reports addressed to this committee contain, among other very interesting documents, a series of catalogues of the appearances of meteorites along with all the circumstances

* Communicated by Prof. J. E. Hilgard, superintendent U. S. coast and geodetic survey. See also *Science*, No. 51.

† Vol. II., p. [illegible]. Third admiralty edition.

‡ Ismyloff was the principal trader at Unalashka, and had produced charts of several of the islands, etc., with which he was personally familiar, and showed them to Cook.

§ This latitude agrees with Cook's.

connected therewith. One of the columns of the catalogue is entitled "Duration," and gives, in fact, the duration of each apparition every time that this important element was noted by the observer. The following are the results that I have deduced therefrom as regards duration. Out of a total number of 565 aerolites, 298 are distributed thus:

117	aerolites	lasted	from	0 to 1	second.
65	"	"	"	1 to 2	"
48	"	"	"	2 to 3	"
23	"	"	"	3 to 5	"
19	"	"	"	5 to 6	"
22	"	"	"	6 to 15	"
1	"	"	"	20	"
5	"	"	"	60	"
1	"	"	"	80	"
1	"	"	"	4	minutes.

It will be seen that 292 out of 298 made their appearance for only a space of time less than a quarter of a minute. The catalogue notes as doubtful three of the longest durations—the ones of 80 and 60 seconds, and that of June 8, 1868, which is said to have reached nearly four minutes. When, in a former communication, I said that the maximum durations of visibility that had been noted were only half a minute, I was wrong. My memory was at fault, or the observations that I have just made known, as well as that of Mr. Coggia, had escaped me. I did indeed recall the observation of Admiral Krusenstern, given by Humboldt in the third volume of *Cosmos;* but this had to do with the *train* of the meteor, and not with the meteor itself—Humboldt saying, in these very terms, "the aerolite whose *tail was seen shining for an hour* by Krusenstern and his companions during their voyage around the world." This train remained visible in the form of a small cloud. Such was also the case with the aerolite of Feb. 10, 1875, observed simultaneously at Paris, Saint Amand, and Aiguillon, and the train of which remained visible for 20, 15, and 25 minutes, according to the place of observation. Finally, I have, myself, in the note cited above and inserted in the *Comptes Rendus* of the Academie des Sciences for 1871, recalled an old observation that I found recorded in No. 431 of the *Philosophical Transactions* (of 1738). I herewith reproduce the curious passage relating to his phenomenon, which had as its witness J. Huxham, Dec. 26, 1737: "In the evening the sky appeared to be covered with a light cloud or haze, which seemed as red as if it were borrowing its color from the reflection of a large fire, and it gave as much light as the moon does when full during a night obscured by clouds. This singular phenomenon lasted till toward midnight. . . . It occupied a great extent in the southern parts of Europe. It appeared at Kilkenny, Ireland, like a sort of globe of fire, which was seen in the air for nearly an hour, and which afterward burst into pieces and threw out flames on every side." Is there a question of an aurora borealis in this narrative, at least as regards the glow observed by Huxham? It seems probable; but the globe of fire seen for an hour was indeed what we call an aerolite. A coincidence between the appearance of shooting stars and aerolites with polar auroras is, moreover, not an isolated fact.

I stop here in this enumeration of aerolites, the duration of whose appearance has been more or less lengthy, and, I may say, exceptional. It would take much more time than I now have to spare to pass in review, with ever so little completeness, all the observations scattered through scientific papers, past and present. Doubtless, there may be among the readers of this journal some who will have the curiosity to pursue this study. I should be pleased especially to have Dr. Jules Reyer gives us the documents that he possesses in regard to the subject. But I doubt whether any of the observations that have been made up to the present day will exceed in clearness and precision that of Mr. Coggia, and be more conclusive than it; and, as I have said above, this suffices to put beyond doubt the fact of a very long duration which it is not so easy to explain.

In reserving, as is usually done, the name *aerolite* for those luminous meteors of sensible diameter, which, like shooting stars themselves, from time to time traverse the higher regions of the atmosphere, and, more rarely, explode and throw out fragments that reach the earth's surface, we may ask ourselves whether the meteor observed by Mr. Coggia had the same nature and origin as aerolites. It is at present very unanimously admitted that shooting stars and aerolites have a cosmic origin, and that their apparition is due to the crossing of their trajectories with the earth's orbit, or the simultaneous passage of our globe and these bodies at the same point of space.

The measurements that have been taken, thanks to concordant observations on the same aerolites, have given for their velocity, heights, etc., figures such that we cannot doubt as to the celestial origin of these bodies—an origin that assimilates them with planets and comets. Such velocity is considerable, at least when the meteors are traversing the highest regions of the air. But precisely for that reason the increasing resistance that they experience on the part of the air that they compress destroys a portion of the live force they possess, converts it into heat, and thus explains both their incandescence and the slight velocity that has always been observed in such of their fragments as reach the earth.

Might not the retardation due to the resistance of the air account for the slow motion of certain aerolites, the one, for example, that was observed by Mr. Coggia? This is not at all improbable, if we think of the change in direction that the meteor underwent; for, after two consecutive stoppages near the stars β and ς of Aquarius, it fell, in fact, according to the author's own words, "with some rapidity perpendicular to the horizon, letting escape what appeared to be incandescent drops." We shall have to admit, then, that its velocity had become sufficiently slight to render preponderant the action of terrestrial gravity; and to bring about a fall of the meteor.

Another explanation would be equally plausible. We do not observe the actual speed of meteors that make their appearance in the atmosphere, since we are ourselves in motion. It is their relative velocity, composed of their own and of the two velocities of rotation and forward movement of the earth. When an aerolite is moving in the same direction as our globe, and with a nearly equal velocity, it is as if two movable objects were traveling side by side, and the resultant velocity must be almost *nil*, or at least very slight. Hence the extreme slowness observed in some aerolites.

Again, we may suppose that certain meteors, on approaching the earth, have a proper velocity for becoming momentarily converted into satellites of our globe. If I am not deceived, one of our learned astronomers, Mr. Petit (of Toulouse), in 1844 calculated the orbits of several aerolites that were considered as satellites of the earth. All such hypotheses would have to be looked into. But in order that they should bear fruit they would have to be based upon very accurate observations, and these unfortunately are quite rare. Phenomena of this kind almost always surprise those who witness them, and this surprise, which is so much the greater in proportion as the meteor is more brilliant or more extraordinary, is a bad condition for accuracy in estimations that are always a little hasty. As was rightly said by Elie De Beaumont, moreover, in speaking of those luminous points or disks that make their appearance in the heavens, "there still exists much that is unknown in this chapter. This is a reason why, without preconceived ideas, all the luminous apparitions that the heavens may exhibit to us should be described with so much the more care and exactness in proportion as the circumstances are more singular, whatever be, moreover, the denomination under which they shall have first been registered."—*Amedee Guillemin, in La Nature.*

SECULAR INCREASE OF THE EARTH'S MASS.

By ALEXANDER WINCHELL.

THE thoughtful and suggestive researches of Ebelmen and T. Sterry Hunt on the chemical and geological relations of the earth's atmosphere* have led me to some further deductions, which seem to increase the interest in this field of inquiry. The general tendency of these studies is to show that the chemical transformations in progress upon the earth involve the fixation of a larger volume of atmospheric constituents than could probably have ever existed in the atmosphere at one time, and that they must consequently have arrived from interplanetary space.

1. *The Carbonates.*—It is generally agreed, as first shown by Hunt, that the carbonates of lime and magnesia have arisen chiefly through the interactions between carbon dioxide of the atmosphere, the decomposing silicates of the earth's crust, and the chloride of calcium of the ocean. The carbon dioxide has therefore been contributed by the atmosphere. To what does this contribution amount? We may assume, without material error, that the carbonates here in question are all calcium carbonate, with a specific gravity of 2·72. Then, the mean pressure of the atmosphere being about 14·7 pounds avoirdupois on a square inch, a little calculation shows that an amount of carbon dioxide in the atmosphere sufficient to double its pressure would yield only 8·627 meters of limestone. An amount sufficient to cause a pressure of 80 atmospheres would suffice for the formation of limestones equal to only a fortieth (0·02265) of the hundred thousand feet which, for this purpose, may be assumed as the thickness of the stratified rocks. But a pressure of 80 atmospheres at a temperature of 30° C. produces liquefaction of carbon dioxide. The actual proportion of limestones and dolomites in the earth's crust is about one-eighth, as I have shown by recent studies. This amount would yield, by the liberation of all its carbon dioxide, a pressure of 441·6 atmospheres. If we consider the limestones and dolomites formed since the period of the coal measures, the proportion required to yield, on the liberation of its carbon dioxide, a pressure of 80 atmospheres, would be only $\frac{1}{22}$ (0·04469) of all the post-Carboniferous strata. The actual proportion is about one-eighth, as for the whole stratified crust; and this would yield sufficient carbon dioxide to cause a pressure of 223·8 atmospheres.

It is not credible that such amounts of carbon dioxide have ever existed in the atmosphere at one time. During the larger part of the æons of carbonate formation, animal life has existed in great abundance upon the earth; and this would have been impossible with 200 to 400 atmospheres of carbon dioxide present. As the proportion of this gas in the existing atmosphere is only 4½ parts in 10,000 by weight, 200 atmospheres of the gas would be 444,000 times the present proportion. It is scarcely more credible that the pressure of 200 to 400 atmospheres would have been compatible with either vegetable or animal organization, so similar as it was fundamentally to modern organization. As this large amount of carbon dioxide cannot be supposed derived from the earth's crust, it must have been derived from interplanetary space. This would imply an addition to the earth's mass of 0·0003806, which is about $\frac{1}{2628}$ part of the present mass.

2. *The Kaolinization of Feldspars.*—Hunt has shown that the kaolinization of a layer of 51·66 meters of orthoclase, or its equivalent of quartzo-feldspathic rocks, would result in 23·7 meters of kaolin, and would use up 10,333 kilogrms. of carbon dioxide per square meter of surface. This is the weight of the atmosphere. Now, the whole amount of feldspathic decomposition during the sedimentary ages must much exceed 500 meters in vertical thickness of kaolinic deposits. But 500 meters of kaolin represent 21·1 atmospheres of carbon dioxide; and, assuming the mass of the atmosphere at $\frac{1}{1200000}$ in relation to the earth, the carbon dioxide fixed in the processes of kaolinization would be 0·0000175826 of the total mass of the earth.

3. *Decay of Hornblende, Pyroxene, and Olivine.*—According to Hunt, the decay of 10½ meters of such minerals, or their equivalents in hornblendic and pyroxenic rocks, would yield carbon dioxide equal to 1 atmosphere; hence, if the earth's crystalline rocks have afforded 500 meters of hornblende and pyroxene, they must have fixed 48.387 atmospheres of carbon dioxide. This, in relation to the earth's mass, is 0·0000403209.

4. *Conversion of Ferrous into Ferric Oxide.*—As Ebelmen states, the conversion of 21,357 kilogrms. of ferrous oxide into 23,750 kilogrms. of ferric oxide would consume the whole of the 2,376 kilogrms. of oxygen in the atmosphere (more exactly, 1·007 atmospheres) covering a square meter. If, then, we suppose the existence over the earth of 1,000 meters of sediments derived from the decay of crystalline rocks containing only one per cent. of ferrous oxide, weighing, according to Hunt, 25,000 kilogrms., this is 1·052 times the amount requisite to fix the oxygen in 1·007 atmospheres; that is, 10 meters of ferric oxide represent the fixation of 1·059 atmospheres of oxygen. This, in relation to the earth's mass, is 0·0000008825.

5. *Unoxidized Carbon.*—This occurs not only in coal-beds, but in pyroschists and petroleum. We find that the oxidation of a layer of carbon 0·7123 meter in thickness would use up all the oxygen in the atmosphere. A layer 2,252 meters thick, and having a specific gravity of 1·25, if converted into carbon dioxide, would exert a pressure of 1 atmosphere. This would amount to 2·267,000 tons of 2,240 pounds each on a square mile. Mr. J. L. Mott calculates that the amount of unoxidized carbon per square mile cannot be less, and is probably many times greater than 3,000,000 tons. If we adopt this determination, it will imply a depth of 0·982 meter, and the proportion of the earth's mass will be 0·00000036318. This is the amount of carbon dioxide which must be decomposed to yield a layer of carbon over the earth only a trifle over three feet in thickness, while it is probable that the carbonaceous deposits of the earth's crust exceed this. Now, it will hardly be maintained that the uncombined carbon of the earth's crust was derived from any other source than the atmosphere and mostly through the agency of vegetation. The earth's atmosphere must therefore have contained all this amount of carbon dioxide. With the fixation of the carbon, the freed oxygen, it may be said, might have been employed, as far as it would go, in the formation of ferric oxide, whose demands upon the atmosphere have just been computed; but as it would only satisfy $\frac{1}{105}$ of those demands, it is hardly necessary to consider the question.

6. *Meteoric Contributions.*—If, as commonly assumed, 400,000,000 meteors enter our atmosphere daily, an average weight of 10 grains each would amount to a yearly addition of 93,170 tons. This, in 100,000,000 years, would amount to 0·000000001542 of the earth's mass, and would form a film 0·292, or nearly $\frac{2}{7}$, of an inch thick, having a density of 2·5.*

Gathering together these various contributions to the earth's mass during 100,000,000 years, we have the following:

1. CO_2 represented by the carbonates...	0·0003806
2. CO_2 fixed in kaolinization of feldspars...	0·0000175826
3. CO_2 fixed in decay of hornblendic and augitic rocks...	0.0000403209
4. O fixed in conversion of ferrous oxide	0·0000008825
5. CO_2 represented by uncombined carbon...	0·00000036318
6. Meteoric contributions...	0·000000001542
Aggregate...	0·000439750722

This is an addition of $\frac{1}{2274}$ to the earth's mass; and, in the present state of knowledge, it does not appear on what grounds assent can be withheld from the result, or some result of similar purport. It must be left with the astronomer to determine what relation this increase may sustain to the moon's acceleration in its orbit and to other phenomena. It may be noted, however, that the remote secular recession and retardation of the moon, which G. H. Darwin has recently brought to view, would have been delayed by the cause here considered, and the time required for the attainment of the moon's present relations would have been prolonged, but to what extent remains to be determined.

The evidences disclosed by these recent researches, of the slow accession of gaseous and solid matters to the earth, possess a profound interest. It would almost seem that the earth's atmosphere is only so much of the intercosmical mixture of gases and vapors as the earth's mass is capable of condensing around it, and that the proportions of these gases are determined separately, each by its own weight and elasticity and by its relative abundance in space; so that, as any one becomes diminished by fixation in the planetary crust, new supplies arrive to keep the ratio constant. As under this view it is apparent that an atmosphere should be accumulated around the moon, even after the saturation of the pores of its rocks, it may be said that the moon's mass and volume are such that her atmosphere would possess only $\frac{1}{34}$, or according to Neison, $\frac{1}{25}$, the density of the earth's atmosphere; and this degree of tenuity might reduce the lunar atmospheric refraction to the small value actually observed.—*Science.*

* See a memoir by T. Sterry Hunt in *American Journal of Science,* May, 1880, where references are given to numerous other publications.

* The value given for this film in a note, p. 14, in my "Worldlife," should be multiplied by 365¼.

THE SUN GLOW.

To the Editor of the Scientific American:

As early as the 15th of last October, I have been a close observer of the red sunset phenomenon which, according to the New York *Sun*, has been seen all over the world. I have been deeply interested in this strange wonder of the upper deep, and will endeavor to describe to your many readers its general visible contour as seen from the Indian Territory.

The sun's disappearance below the western horizon is followed by a reddish tinge in the eastern sky, which rises higher and higher as the sun sinks lower and lower beneath the western sky. After this red glow has reached a distance of about 30° it assumes a semicircular form, which, perhaps, is a reflection of the red halo which surrounded the sun previous to his setting. This semicircle of red light lasts only for a few minutes, when it apparently vanishes and invisibly passes overhead to reappear in a fiery glow in the west, causing the brilliant planet Venus to appear in all her beauty and glory. This first illumination finally disappears under the western horizon in the form of a beautiful red band. Just about the time, however, that this reflection is fairly down, the sky in the east begins to redden with the second reflection, which is in every particular like the former reflection, with this exception; in the formation and motion of the second illumination, there is no reflection thrown from the west on to the eastern sky of a half circle form of red light.

Now, the luminosity preceding sunrise is similar to the sunset appearance, only in a somewhat reversed order, that is, it is the last sunrise glow that throws its image, in the form of a semicircle, on the western sky.

During the fall months, I did not notice that the halo around the sun was of a red color, in fact, I am confident that it was of a brilliant silvery appearance, having more the appearance of illuminated sand in the air. It was not until about the latter part of December that I noticed the color of the halo being red, of which color it continues to be up to the present time.

Another peculiarity, the most remarkable of all, is, the dim white streaks, resembling some clouds we see, notably, the stratus, that constantly follow the sun in his daily course from east to west. These white streaks, which seemed to run from east to west during the day, could be seen, after sundown and just before sunrise, running parallel with one another, from northeast to southwest at sundown, and from north to south before sunrise. But after sunrise and before sundown they could not be seen until quite recently.

The sunset was remarkably red and expansive on the evening of January 28, 1884.

The evening of January 31 and morning of February 1, the white parallel streaks were remarkably well defined—the greater part being in the north. Cloudy weather with rain and snow then followed for twelve days, which prevented further observation.

On the morning of February 14, it being very clear, the streaks were again remarkably well defined—the streaks were seen in the west as well as in the east. The circle around the sun was red all day long.

On the evening of February 18, there was only one reflection of a red color; the other reflection being a pale yel-

lowish color, which become blended with the zodiacal light, causing an unusually long twilight.

On the 19th of February, in the evening, (the morning being cloudy), the white streaks were visible directly in the afternoon in the northwest and also in the northeast, though dimly in the last named point. The sunset gave only one red reflection—the other being a yellowish white, blending with the zodiacal light; the streaks, for the first time, being seen in both reflections. On the evening of February 22, the white streaks began to be visible immediately in the afternoon. Another hitherto unobserved phase of phenomenon appeared on this evening, to wit; the streaks were in two layers—the parallel streaks in one layer ran from northeast to southwest; the streaks of the other layer ran from north to south.

On the 27th February, the streaks assumed a strange and unlooked for form. These streaks, which before, up to this evening, had been parallel with an occasional lap or twist, assumed a bold sweep of several concentric curves about 45° east of a point where the sun went down. The diameter of the outer curve or ring was about 25°; these curves faded away when the red glow set in. This was a remarkable peculiarity of the atmospheric dust.

At all times, as far as my observations go, the white streaks, when visible in the evening, converged at a point about 15° south of where the sun went down, with the following exception, viz.: On the evening of March 2, after a north wind had been blowing for several days, the streaks appeared well defined; but instead of converging to the south, they came to a focus at about the same distance from the point where the sun went down, only to the north. And instead of the red light being confined, as usual to the south, it was in the north.

On the night of February 25, directly after twilight, the sky being somewhat cloudy with thin misty clouds, through which the stars could be dimly seen, strange sights appeared in the form of pseudo-comets, which are unusual, and, as far is my knowledge goes, utterly unknown in this country up to this time. These comet-like appearances were seen directly over firelights, as the praries and woods were on fire at this time, in places here and there in the vicinity.

WM. EUBANKS.

March 5, 1884.

MINERAL RESOURCES OF THE UNITED STATES.

By ALBERT WILLIAMS.

ABSTRACT No. 1. COAL.

THE volume of the U. S. Geological Survey devoted to a discussion of the mining statistics of the United States comprises a mass of information which the casual reader has no time to deal with, and to whom its formidable array of tables and analyses appears abhorrent and distasteful. The subject has been handled by one perhaps better instructed through experience and study in this class of facts than any living mining expert, and by one drawn to their investigation from taste and habit. To supply ordinary inquiries about the metallic and mineral wealth of our country, considered from a commercial point of view, it is hoped these abstracts will prove useful and adequate.

Coal, as the essential source of all mining capabilities and the motor of modern civilization with its engines and its comforts, appropriately forms the first topic dealt with, a treatment justified still further by the consideration that coal is the principal mineral product of the United States.

In 1882 the total output of coal for the United States was 92,219,454 tons (2,240 lb. to one ton), of which 60,861,190 tons were bituminous coal, 31,358,264 tons anthracite. At an average price of $1.25 per ton for bituminous coal and $2.25 per ton for anthracite the spot value (viz., cost at mines) is $146,632,581, or about twice the assay value of the precious metal output. This computation includes the coal consumed at the collieries, and of course exceeds the amount of coal received in the markets, or the commercial product, which for bituminous coal was 57,963,038 tons, and 29,120,096 tons of anthracite, making a total of 87,083,134 tons.

The area from which this coal is derived embraces in round numbers 192,000 sq. miles, exclusive of the Rocky Mountain and Pacific coast areas, of which latter it is supposed Colorado contains 35,000, Montana 60,000, Wyoming 20,000, Dakota 100,000 sq. miles. The eastern and middle division embraced in the first statement, 192,000 sq. miles, is partitioned as follows:

New England basin	500	sq. miles.
Pennsylvania anthracite	468½	" "
Appalachian basin	58,265	" "
Michigan "	6,700	" "
Illinois "	47,138	" "
Missouri "	26,887	" "
Texas "	4,500	" "
Iowa	18,000	" "
Nebraska	170,000	" "
Arkansas	9,043	" "
Kansas	17,000	" "
Virginia	185	" "
North Carolina	310	" "

The total output of coal in the census reports of 1870 was 33,310,905 net tons, while in that of 1880 it is given as 71,067,576 net tons. The production in gross tons of coal for 1881 of Great Britain, United States, Germany, France, Belgium, Austria, Russia, and India compares as follows:

Great Britain	154,184,300
United States	76,679,491
Germany	61,540,475
France	19,909,057
Belgium	17,500,000
Austria	19 000,000
Russia	3,255,000
India	4,000,000

Pennsylvania, in both varieties of coal, bituminous and anthracite, leads the States, summing up in tons produced in 1880, of anthracite coal 28,640,819 tons, of bituminous 18,425,163 tons. The regions in this State which produce coal are broadly designated as the Schuylkill, Lehigh, Wyoming, which respectively yielded anthracite in 1880 the following amounts, 7,554,742 tons; 4,463,221 tons; 11,419,279 tons.

The tendency in desirable forms of coal is toward prepared sizes, as the small sizes sell for so much more. This result has been brought about by the introduction of base burning stoves. Waste anthracite has attracted the attention of economical engineers and wise business men, and it is now utilized upon an enormous scale; 60 per cent. of the contents of a mine are extracted; of that 15 or 20 per cent. is wasted in its preparation. In the dirt banks of the Philadelphia and Reading Coal and Iron Co. there are 60,000,000 tons of mingled coal fragments, dirt, and dust, of which 40,000,000 can be used for fuel. In this waste much coal is found which is good stove coal. This material, called *culm*, is now extensively used at the collieries under the boilers. The Philadelphia & Reading R.R. Co. will have 100 "dirt burning" locomotives in use by January, 1884.

In Alabama there are 10,680 sq. miles of coal producing country, all bituminous, of which in 1880 the output was 340,000 gross tons; in 1882, 800,000.

Colorado has a great extent of coal producing country, varying according to different estimates from 20,000 to 50,000 sq. miles. It is increasingly mined with the increasing industries of the State. In Northern Colorado the coal is a lignite, jet black, high luster, sp. gr. 1·33; 4 per cent. of sulphur, and showing no fibrous or woody structure as a rule; ash, 2 to 8 per cent.; water, 12 to 14.8 per cent. The beds average 6 ft. in width. In the middle division the coal is semi-bituminous; sulphur 0·35 per cent., ash 4 to 12 per cent., water 4·5 to 12·9 per cent. Southern division yields bituminous coal, sulphur 0·65 to 1 per cent., ash 6·30 to 8·28 per cent., water 5 to 3 per cent. Beds are sometimes 90 ft. in thickness, average width about 10 ft.

The northwestern division yields the only true anthracite found west of the Alleghanies, which in many instances appears to be directly due to the proximity of ingneous dikes.

The total output of Colorado for 1880 was 437,005 net tons, which in 1881 rose to 706,744, and in 1882 to 1,061,479.

Illinois has abundance of coal, and it is widely distributed. Although the census report for 1880 credits this State with a comparatively small yield, the actual ability of the coal fields is enormous, amounting by a very low calculation to 28,845,000,000 tons. This has not yet been more than broached, and offers a supply for centuries of industrial progress.

In Indiana one-fifth of the State produces coal which is entirely bituminous, varying in character as the list, familiar to coal dealers, shows:

Coking coal, long flame, gas and smith coal, fat coal.

Semi-coking coal, long flame.

Block coal, non-coking coal, long flame, dry burning coal, furnace coal.

Semi-block coal, long flame.

Cannel coal, long bright flame, dry burning, gas coal.

In Iowa there is a very considerable area of coal producing land, and the output has risen from 350,000 gross tons in 1873 to 3,500,000 in 1882. In Kentucky the actual extent of the coal fields is unknown, but the coal mined there is of a superior quality, and the continuation of the valuable deposits of coking coals of Pennsylvania and West Virginia has been established in Kentucky.

Maryland has a restricted coal field, but the product is superior, and transportation facilities bring its coal quickly to market. Missouri yielded in 1882 2,000,000, gross tons of coal. Montana has an unknown but probably enormous territory holding coal. New Mexico has coals ranging from brown lignite to anthracite, which are awaiting development.

In Ohio the coal industry is an important one, and the coals are various in character, though all bituminous. "The best furnace coal is the block coal of the Mahoning Valley; the best coke is made from coals at Letonia and Washingtonville in Columbiana County; the best house coal is found in Jackson County; the best gas coal, so far as recent tests would seem to indicate, is the Barnesville coal of Belmont County."

Ohio now ranks second in the list of coal-producing States; its coal field occupies one-third the area of the State. The coal area of Tennessee covers 5,100 sq. miles upon the Cumberland plateau, and exposes upon mining one to seven workable seams of coal.

The output has risen from 350 000 gross tons in 1873 to 850,000 in 1882. Texas coal fields are being opened.

In Utah the approaching development of its great iron resources will rapidly lead to the exploration of its coal bearing areas, which are extensive.

West Virginia coals are well known, and contain the most workable seams of coal in the great Appalachian coal field. The beds are numerous enough to make about 40 coal beds, which aggregate not far from 175 feet of coal. The coke works of West Virginia use a large proportion of the entire yield in the manufacture of this useful metallurgical agent. Gas coal is shipped from these fields in large quantities.

Wyoming offers a lignite of superior quality. Its resources in this particular were first opened upon the completion of the Union Pacific railroad to Carbon in 1868. The production has become very large, rising from 6,925 net tons in 1868 to 707,764 in 1882.

California, Oregon, Washington, yield coal, the wealth of the two latter being as yet undetermined.

The price of coal varies with factors or many kinds; as a rule, price of coal is low in spring, and rises to December. In 1860 in New York the highest price per ton was $6.00, which rose to $15.00 in 1864; it sank to $13.00 in 1867; it continued to fall until 1871, when it rose from $8.50 of the preceding year to $13.00, from which point it has declined to $4.85 in 1882. These prices apply only to anthracite.

Despite the accidents in mines, which are so often overwhelming and tragic, and which produce the impression of the precarious nature of the miner's life, statistics prove that the death rate among miners is not greater than that among men engaged in surface pursuits, and that the moderate and uniform temperature of the mines conduces to health.

L. P. G.

SUBMARINE TELEGRAPH COMMUNICATION TO LIGHT SHIPS.

THE main difficulties attending the connection of submarine telegraph cables to light ships and other moored vessels have been caused by the swinging of the ship, and its change of position when veering away in heavy weather. The effect of the swinging is to twist the telegraph cable and the mooring chain together, and the frequent cutting away and replacing of long lengths of the telegraph cables is thus necessitated. To avoid both these evils Mr. H. M. Goodman, of Rochdale, Worple Road, Wimbledon, has patented an apparatus which consists essentially of a hollow tube or shaft provided with suitable bearings, and with means of rotation; through this tube the mooring chain from an ordinary windlass passes. This chain, after leaving the tube, goes through the center of a rotary hawse pipe in the fore part of the ship, provided with gearing for rotating it, and thence to the anchor or mushroom mooring. On the hollow chain tube is a drum which has coiled upon it a sufficient length of telegraph cable for veering away, and is provided with a friction brake band adjustable by means of screws. One end of the telegraph cable is made fast to, but electrically insulated from, the drum, while the other end passes through a hole in the rotary hawse pipe parallel to, but at one side of, the central hole, through which the mooring chain passes, and thence it goes to a heavy weight with a hemispherical top sunk on the sea bottom. By this arrangement the telegraph cable is paid out automatically during the veering away of the anchor chain. As the anchor chain is shortened, the cable drum is rotated by gearing. By noting the direction in which the ship is swinging, and suitably turning the rotary hawse pipe and chain tube, together with the cable drum, fouling of the anchor with the telegraph cable and twisting of the latter are simply and effectively prevented, the telegraph cable being untwisted by the motion of the hawse pipe at the same time as it is twisted by the motion of the vessel. To retain perfect electrical continuity between the instrument and the cable, the insulated end of the latter is connected to a disk attached to, but insulated from, the drum shaft, rubbing contact being made with the disk by a metallic strip connected with the lead passing to the operator's room. That portion of the telegraph cable between the sunk weight and ship which lies upon the sea bottom is provided with suitable means for facilitating its passage over the ground and preventing its abrasion thereby. The details of the apparatus, a model of which has been constructed by the inventor, appear to have been thoroughly worked out in a simple and effective manner.

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